

**Society for Computer Technology & Research 's (SCTR's)**

**Pune Institute of Computer Technology (PICT), Pune**

**An Autonomous Institute affiliated to the Savitribai Phule Pune University (SPPU)**

**Approved by AICTE & Government of Maharashtra,**

**Accredited by NAAC (A+) & NBA [All eligible UG Programs]**



**Syllabus for**  
**T.Y. B. Tech Computer Engineering**

**With effect from (AY 2026-27)**

**National Education Policy (NEP) 2020 Compliant**

**Approved by the Board of Studies (BoS) and Academic Council**



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### Abbreviations used

| Sr. No. | Broad Category of the course                               | Sub- Category of course                                                                                                              | Category Code |
|---------|------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|---------------|
| 1.      | Basic Science/<br>Engineering Science<br>Course (BSC/ ESC) | Basic Science Course (BSC)                                                                                                           | BS            |
|         |                                                            | Engineering Science Course (ESC)                                                                                                     | ES            |
| 2.      | Program Courses (PC)                                       | Program Core Course (PCC)                                                                                                            | PC            |
|         |                                                            | Program Elective Course (PEC)                                                                                                        | PE            |
| 3.      | Multidisciplinary<br>Courses (MC)                          | Multidisciplinary Minor (MDM)                                                                                                        | MD            |
|         |                                                            | Open Elective (OE)                                                                                                                   | OE            |
| 4.      | Skill Courses (SC)                                         | Vocational and Skill Enhancement Course (VSEC)                                                                                       | VS            |
| 5.      | Humanities Social<br>Science and<br>Management (HSSM)      | Ability Enhancement Course (AEC-01, AEC-02)                                                                                          | AE            |
|         |                                                            | Entrepreneurship/Economics/<br>Management Courses (EEM)                                                                              | EE            |
|         |                                                            | Indian Knowledge System (IKS)                                                                                                        | IK            |
|         |                                                            | Value Education Course (VEC)                                                                                                         | VE            |
| 6.      | Experiential Learning<br>Courses (ELC)                     | Research Methodology (RM)                                                                                                            | RM            |
|         |                                                            | Community Engagement Project (CEP) /<br>Field Project (FP)                                                                           | CE            |
|         |                                                            | Project (PRJ)                                                                                                                        | PR            |
|         |                                                            | Internship/ On Job Training (IP/OJT)                                                                                                 | IP            |
| 7.      | Liberal Learning<br>Courses (LLC)                          | Co-curricular Activities (CCA)                                                                                                       | CC            |
| 8.      | Honors Courses (HC)                                        | Offered within the same branch depth in the<br>same branch (advanced specialization &<br>research).                                  | HC            |
| 9.      | Minor Courses (MIC)                                        | Offered by other branches breadth across<br>disciplines (interdisciplinary exposure,<br>applied projects).                           | MC            |
| 10.     | Double Minor Courses<br>(DMC)                              | Additional minor to be offered by other<br>branches breadth across disciplines<br>(interdisciplinary exposure, applied<br>projects). | DM            |

Detailed guidelines for examination:

Link: [Guidelines for examination](#)

### Semester wise distribution of Credits and Marks

| Class  | Sem-I – Credits | Sem-II – Credits | Total Credits | Sem-I – Marks | Sem-II – Marks | Total Marks |
|--------|-----------------|------------------|---------------|---------------|----------------|-------------|
| FY     | 20              | 20               | 40            | 725           | 750            | 1475        |
| SY     | 22              | 22               | 44            | 750           | 750            | 1500        |
| TY     | 20              | 20               | 40            | 750           | 750            | 1500        |
| B-Tech | 20              | 16               | 36            | 700           | 400            | 1100        |
| Total  | 82              | 78               | 160           | 2925          | 2650           | 5575        |

### Third Year B.Tech. (Semester - 5)

| Semester V         |             |                                                        | Teaching Scheme<br>(Hours/Week) |    |   |       | Credits/ Grades |   |   |       | Examination Scheme and Marks |      |      |           |      |      |       |
|--------------------|-------------|--------------------------------------------------------|---------------------------------|----|---|-------|-----------------|---|---|-------|------------------------------|------|------|-----------|------|------|-------|
| Category of Course | Course code | Name of the Course (Short forms)                       | L                               | P  | T | Total | L               | P | T | Total | Theory                       |      |      | Practical |      |      | Total |
|                    |             |                                                        |                                 |    |   |       |                 |   |   |       | CIE                          | ISE  | ESE  | CIE       | ESE  |      |       |
|                    |             |                                                        |                                 |    |   |       |                 |   |   |       | [20]                         | [20] | [60] | TW        | (PR) | (OR) |       |
| PCC                | 2615PC11    | <a href="#">Computer Networks(CN)</a>                  | 2                               | -  | - | 2     | 2               | - | - | 2     | 20                           | 20   | 60   | -         | -    | -    | 100   |
| PCC                | 2615PC12    | <a href="#">Theory of Computation (TOC)</a>            | 3                               | -  | - | 3     | 3               | - | - | 3     | 20                           | 20   | 60   | -         | -    | -    | 100   |
| PCC                | 2615PC13    | <a href="#">Artificial Intelligence(AI)</a>            | 3                               | -  | - | 3     | 3               | - | - | 3     | 20                           | 20   | 60   | -         | -    | -    | 100   |
| PCC                | 2615PC31    | <a href="#">Computer Networks Lab(CNL)</a>             | -                               | 2  | - | 2     | -               | 1 | - | 1     | -                            | -    | -    | 25        | -    | 25   | 50    |
| PCC                | 2615PC32    | <a href="#">Artificial Intelligence Lab(AIL)</a>       | -                               | 2  | - | 2     | -               | 1 | - | 1     | -                            | -    | -    | 25        | 25   | -    | 50    |
| PEC                | 2615PE1X    | <a href="#">Program Elective-I</a>                     | 3                               | -  | - | 3     | 3               | - | - | 3     | 20                           | 20   | 60   | -         | -    | -    | 100   |
| PEC                | 2615PE31    | <a href="#">Program Elective-I Lab</a>                 | -                               | 2  | - | 2     | -               | 1 | - | 1     | -                            | -    | -    | 25        | 25   | -    | 50    |
| MDM                | 2605MD1X    | <a href="#">MDM - 3</a>                                | 2                               | -  | - | 2     | 2               | - | - | 2     | 20                           | 20   | 60   | -         | -    | -    | 100   |
| MDM                | 2605MD3X    | <a href="#">MDM - 3 #</a>                              | -                               | 2  | - | 2     | -               | 1 | - | 1     | -                            | -    | -    | 25        | -    | -    | 25    |
| AEC                | 2605AE31    | <a href="#">Leadership and Management Skills (LMS)</a> | -                               | 2  | - | 2     | -               | 1 | - | 1     | -                            | -    | -    | 25        | -    | -    | 25    |
| OE                 | 2605OE51    | <a href="#">Open Elective -III *</a>                   | -                               | -  | 2 | 2     | -               | - | 2 | 2     | -                            | -    | 50   | -         | -    | -    | 50    |
| Total              |             |                                                        | 13                              | 10 | 2 | 25    | 13              | 5 | 2 | 20    | 100                          | 100  | 350  | 125       | 50   | 25   | 750   |

#: Tutorial or laboratory as applicable. MDLX-X: First X is basket number; Second X is course number in that basket, L, P, and T has usual meaning.

[Refer Annexure-I for MDM details.](#)

\*: Open elective (OE) offered by online platforms such as SWAYAM/NPTEL.

[Refer Annexure-II for OE details.](#)

### Third Year B.Tech. ( Semester - 6 )

| Semester- VI          |                |                                                                            | Teaching Scheme<br>(Hours/Week) |    |   |       | Credits/ Grades |   |   |       | Examination Scheme and Marks |      |      |           |      |      |       |
|-----------------------|----------------|----------------------------------------------------------------------------|---------------------------------|----|---|-------|-----------------|---|---|-------|------------------------------|------|------|-----------|------|------|-------|
| Category<br>of Course | Course<br>code | Name of the Course<br>(Short forms)                                        | L                               | P  | T | Total | L               | P | T | Total | Theory                       |      |      | Practical |      |      | Total |
|                       |                |                                                                            |                                 |    |   |       |                 |   |   |       | CIE                          | ISE  | ESE  | CIE       | ESE  |      |       |
|                       |                |                                                                            |                                 |    |   |       |                 |   |   |       | [20]                         | [20] | [60] | TW        | (PR) | (OR) |       |
| PCC                   | 2616PC11       | <a href="#">Cloud and Distributed Computing(CDC)</a>                       | 3                               | -  | - | 3     | 3               | - | - | 3     | 20                           | 20   | 60   | -         | -    | -    | 100   |
| PCC                   | 2616PC12       | <a href="#">Design and Analysis of Algorithms(DAA)</a>                     | 2                               | -  | - | 2     | 2               | - | - | 2     | 20                           | 20   | 60   | -         | -    | -    | 100   |
| PCC                   | 2616PC31       | <a href="#">Software Lab. (SL)</a>                                         | -                               | 2  | - | 2     | -               | 1 | - | 1     | -                            | -    | -    | 25        | 25   | -    | 50    |
| MDM                   | 2606MD1X       | <a href="#">MDM - 4</a>                                                    | 2                               | -  | - | 2     | 2               | - | - | 2     | 20                           | 20   | 60   | -         | -    | -    | 100   |
| MDM                   | 2606MD3X       | <a href="#">MDM - 4 #</a>                                                  | -                               | 2  | - | 2     | -               | 1 | - | 1     | -                            | -    | -    | 25        | -    | -    | 25    |
| VSEC                  | 2616VS31       | <a href="#">Seminar/Technical Presentation Based on Mini Project (STP)</a> | -                               | 2  | - | 2     | -               | 1 | - | 1     | -                            | -    | -    | -         | -    | 25   | 25    |
| PEC                   | 2616PE1X       | <a href="#">Program Elective-II</a>                                        | 3                               | -  | - | 3     | 3               | - | - | 3     | 20                           | 20   | 60   | -         | -    | -    | 100   |
| PEC                   | 2616PE2X       | <a href="#">Program Elective-III</a>                                       | 3                               | -  | - | 3     | 3               | - | - | 3     | 20                           | 20   | 60   | -         | -    | -    | 100   |
| PEC                   | 2616PE31       | <a href="#">Program Elective-II and III Lab.</a>                           | -                               | 4  | - | 4     | -               | 2 | - | 2     | -                            | -    | -    | 50        | 50   | -    | 100   |
| OE                    | 2606OE51       | <a href="#">Open elective -IV *</a>                                        | -                               | -  | 2 | 2     | -               | - | 2 | 2     | -                            | -    | 50   | -         | -    | -    | 50    |
| Total                 |                |                                                                            | 13                              | 10 | 2 | 25    | 13              | 5 | 2 | 20    | 100                          | 100  | 350  | 100       | 75   | 25   | 750   |

### Program Elective Courses-I (PEC-I)

| Course Code | Course name                                                    |
|-------------|----------------------------------------------------------------|
| 2615PE11    | <a href="#">Data Warehousing and Mining (DWM)</a>              |
| 2615PE12    | <a href="#">File Systems and Rust Programming (FSRP)</a>       |
| 2615PE13    | <a href="#">Computer Graphics (CG)</a>                         |
| 2615PE14    | <a href="#">Client-Side Technologies and Frameworks (CSTF)</a> |
| 2615PE15    | <a href="#">Cryptography (CGR)</a>                             |

| Program Elective-II |                                                  | Program Elective-III |                                                   |
|---------------------|--------------------------------------------------|----------------------|---------------------------------------------------|
| Course Code         | Course name                                      | Course Code          | Course name                                       |
| 2616PE11            | <a href="#">Machine Learning (ML)</a>            | 2616PE21             | <a href="#">Natural Language Processing (NLP)</a> |
| 2616PE12            | <a href="#">Big Data Analytics (BDA)</a>         | 2616PE22             | <a href="#">Embedded OS (EOS)</a>                 |
| 2616PE13            | <a href="#">Human Computer Interaction (HCI)</a> | 2616PE23             | <a href="#">Computer Vision (CV)</a>              |
| 2616PE14            | <a href="#">Software Defined Networks (SDN)</a>  | 2616PE24             | <a href="#">Server Side Technologies (SST)</a>    |
| 2616PE15            | <a href="#">Cyber Security (CS)</a>              | 2616PE25             | <a href="#">Data Privacy and Ethics (DPE)</a>     |

### Multi-Disciplinary Minor (MDM)

|     |                |                                           | Teaching Scheme<br>(Hours/Week) |   |   |       | Credits |   |   |       | Examination Scheme and Marks |      |      |           |      |      |       |
|-----|----------------|-------------------------------------------|---------------------------------|---|---|-------|---------|---|---|-------|------------------------------|------|------|-----------|------|------|-------|
| Sem | Course<br>code | Name of<br>the Course<br>(Short<br>forms) | L                               | P | T | Total | L       | P | T | Total | Theory                       |      |      | Practical |      |      | Total |
|     |                |                                           |                                 |   |   |       |         |   |   |       | CIE                          | ISE  | ESE  | CIE       | ESE  |      |       |
|     |                |                                           |                                 |   |   |       |         |   |   |       | [20]                         | [20] | [60] | TW        | (PR) | (OR) |       |
| 3   | 2603MD11       | MDM-1                                     | 2                               | - | - | 2     | 2       | - | - | 2     | 20                           | 20   | 60   | -         | -    | -    | 100   |
| 3   | 2603MD51       | MDM-1 Tut                                 | -                               | - | 1 | 1     | -       | - | 1 | 1     | -                            | -    | -    | 25        | -    | -    | 25    |
| 4   | 2604MD11       | MDM-2                                     | 2                               | - | - | 2     | 2       | - | - | 2     | 20                           | 20   | 60   | -         | -    | -    | 100   |
| 4   | 2604MD31       | MDM-2 Lab                                 | -                               | 2 | - | 2     | -       | 1 | - | 1     | -                            | -    | -    | 25        | -    | -    | 25    |
| 5   | 2605MD11       | MDM-3                                     | 2                               | - | - | 2     | 2       | - | - | 2     | 20                           | 20   | 60   | -         | -    | -    | 100   |
| 5   | 2605MD31       | MDM-3 Lab                                 | -                               | 2 | - | 2     | -       | 1 | - | 1     | -                            | -    | -    | 25        | -    | -    | 25    |
| 6   | 2606MD11       | MDM-4                                     | 2                               | - | - | 2     | 2       | - | - | 2     | 20                           | 20   | 60   | -         | -    | -    | 100   |
| 6   | 2606MD31       | MDM-4 lab                                 | -                               | 2 | - | 2     | -       | 1 | - | 1     | -                            | -    | -    | 25        | -    | -    | 25    |
| 8   | 2607MD11       | MDM-5                                     | -                               | - | 2 | 2     | -       | - | 2 | 2     | -                            | -    | -    | 50        | -    | -    | 50    |
|     |                | Total                                     | 8                               | 6 | 3 | 17    | 8       | 3 | 3 | 14    | 80                           | 80   | 240  | 150       | 0    | 0    | 550   |

### Proposed Structure: Program Elective Courses (PEC)

|     |                |                                        | Teaching Scheme<br>(Hours/Week) |    |   |       | Credits |   |   |       | Examination Scheme and Marks |      |      |           |      |      |       |
|-----|----------------|----------------------------------------|---------------------------------|----|---|-------|---------|---|---|-------|------------------------------|------|------|-----------|------|------|-------|
| Sem | Course<br>code | Name of the<br>Course<br>(Short forms) | L                               | P  | T | Total | L       | P | T | Total | Theory                       |      |      | Practical |      |      | Total |
|     |                |                                        |                                 |    |   |       |         |   |   |       | ISE                          | CIE  | ESE  | CIE       | ESE  |      |       |
|     |                |                                        |                                 |    |   |       |         |   |   |       | [20]                         | [20] | [60] | TW        | (PR) | (OR) |       |
| 5   | 2615PE1X       | Program Elective-I                     | 3                               | -  | - | 3     | 3       | - | - | 3     | 20                           | 20   | 60   | -         | -    | -    | 100   |
| 5   | 2615PE3X       | Program Elective-I<br>Lab              | -                               | 2  | - | 2     | -       | 1 | - | 1     | -                            | -    | -    | 25        | -    | 25   | 50    |
| 6   | 2616PE1X       | Program Elective-<br>II                | 3                               | -  | - | 3     | 3       | - | - | 3     | 20                           | 20   | 60   | -         | -    | -    | 100   |
| 6   | 2616PE2X       | Program<br>Elective-III                | 3                               | -  | - | 3     | 3       | - | - | 3     | 20                           | 20   | 60   | -         | -    | -    | 100   |
| 6   | 2616PE31       | Program Elective- II<br>& III Lab      | -                               | 4  | - | 4     | -       | 2 | - | 2     | -                            | -    | -    | 50        | 50   | -    | 100   |
| 7   | 2717PE1X       | Program Elective-IV                    | 3                               | -  | - | 3     | 3       | - | - | 3     | 20                           | 20   | 60   | -         | -    | -    | 100   |
| 7   | 2717PE2X       | Program Elective-V                     | 3                               | -  | - | 3     | 3       | - | - | 3     | 20                           | 20   | 60   | -         | -    | -    | 100   |
| 7   | 2717PE41       | Program Elective-IV<br>and V Lab       | -                               | 4  | - | 4     | -       | 2 | - | 2     | -                            | -    | -    | 50        | -    | 50   | 100   |
|     |                | Total                                  | 15                              | 12 | - | 27    | 15      | 6 | - | 20    | 100                          | 100  | 300  | 125       | 50   | 75   | 750   |

## List of Multi-Disciplinary Minor Domains

| Sr. No. | Multi-Disciplinary Minor Domains          | SY                                                         |                                                      | TY                                                                                                                   |                                                                                                        | B-Tech                                             | Offered to students of B.Tech Program |
|---------|-------------------------------------------|------------------------------------------------------------|------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|----------------------------------------------------|---------------------------------------|
|         |                                           | MDM-1                                                      | MDM-2                                                | MDM-3                                                                                                                | MDM-4                                                                                                  | MDM-5                                              |                                       |
|         |                                           | Sem-3                                                      | Sem-4                                                | Sem-5                                                                                                                | Sem-6                                                                                                  | Sem-7/8                                            |                                       |
| MD1     | Smart and Sustainable Systems (SSS)       | Fundamentals of Smart and Sustainable Systems (FSSS) & Tut | IoT for Smart and Sustainable Systems (ISSS) & Lab   | Data Analytics for Smart and sustainable systems (DASSS) & Data Analytics for Smart and sustainable systems (DASSSL) | Security for Smart and Sustainable Systems (SSS) & Smart and Sustainable Systems Development (SSD) Lab | Smart and Sustainable System (SSD) (MOOC)          | ALL                                   |
| MD2     | Financial Technology and Management (FTM) | Finance and Management (FM)                                | Fundamentals of Financial Engineering (FFE) & Tut    | Banking, Financial Services and Insurance (BFSI) & Tut                                                               | Fundamentals of Stock Market (FSM) & Tut                                                               | Fintech: Foundations & Applications (FFA) & Tut    | ALL                                   |
| MD3     | 3D- Printing (3DP)                        | 3D- Printing (3DP)                                         | 3D modeling and Design (3MD) & Lab                   | Fundamentals of Additive Manufacturing (FAM)& Lab                                                                    | 3D Printing Materials and Processes (3DPMP)                                                            | Industry 4.0 and Digital Manufacturing (IDM)       | ALL                                   |
| MD4     | Electric Vehicles (EV)                    | Electric Vehicles (EV)                                     | EV foundation – Principles and Concepts (EVPC) & Lab | Advanced Motor Technologies and Power Electronics for EV(AMT) & Lab                                                  | EV Powertrain Dynamics and Control System(PDC) Tut/Lab                                                 | Intelligent EV Systems: AI IoT and Automation(IEV) | ALL                                   |
| MD5     | Applied Mathematics for Engineering (AME) | Applied Mathematics for Engineering (AME)                  | Linear Algebra with Python & Lab                     | Statistical Techniques and Numerical Methods with R & Lab                                                            | Fuzzy Logic and Graph Theory with Matlab/Python & Lab                                                  | Optimization Techniques & Lab                      | ALL                                   |

|             |                                                 |                                           |                                              |                                                  |                                              |                                           |                             |
|-------------|-------------------------------------------------|-------------------------------------------|----------------------------------------------|--------------------------------------------------|----------------------------------------------|-------------------------------------------|-----------------------------|
| <b>MD6</b>  | <b>Software Development (SD)</b>                | Software Development (SD)                 | Data Structures and Algorithms (DSA) & Lab   | Object Oriented Programming (OOP) & Lab          | Database and Management Systems (DBMS) & Lab | Web Development (WD) & Lab                | <b>E&amp;TCE</b>            |
| <b>MD7</b>  | <b>Autonomous and Intelligent Systems (AIS)</b> | Autonomous and Intelligent Systems (AIS)  | Digital Systems and Organization (DSO) & Lab | Smart System Engineering (SSE) & Lab             | Embedded IoT Systems (EIS) & Lab             | Autonomous Systems (AS) & Lab             | <b>All except E&amp;TCE</b> |
| <b>MD8</b>  | <b>Embedded Systems- (ES)</b>                   | Embedded Systems (ES)                     | Fundamental of Microcontroller (FM) & Lab    | Embedded Processors –I (EP -I) & Lab             | Microcontrollers and IoT (MI) & Lab          | Embedded Systems and RTOS (ES-RTOS) & Lab | <b>All Except E&amp;TCE</b> |
| <b>MD9</b>  | <b>AI &amp; Machine Learning (AI-ML)</b>        | AI & Machine Learning (AI-ML)             | Statistical Data Analysis & Lab              | Machine Learning (ML) & Lab                      | Natural Language Processing (NLP) & Lab      | Artificial Intelligence (AI) & Lab        | <b>E&amp;CE</b>             |
| <b>MD10</b> | <b>Quantum Computing (QC)</b>                   | Foundations of Quantum Technologies & Lab | Foundations of Quantum Computing & Lab       | Basic Programming for Scientific Computing & Lab | Introduction to Quantum Computation & Lab    | Mini Project / Case Study Lab (MP/CS)     | <b>ALL</b>                  |

### List of Program Elective Courses (PEC)

- Students can choose elective courses from a wide range of disciplines, promoting a holistic and interdisciplinary education.
- Electives can be selected from within the student's core discipline or from other fields, encouraging exploration and broadening of knowledge.

| TY-I<br>PEC_I                           | TY-II(1)<br>PEC_II         | TYII-(2)<br>PEC_III         | Final Year-I<br>PEC_IV                | Final Year-I<br>PEC_V                |
|-----------------------------------------|----------------------------|-----------------------------|---------------------------------------|--------------------------------------|
| Data Warehousing and Mining             | Machine Learning           | Natural Language Processing | Deep Learning                         | Generative AI                        |
| File Systems and Rust Programming       | Big Data Analytics         | Embedded Operating System   | DevOps (Development and Operations)   | MLOps (Machine Learning Operations)  |
| Computer Graphics                       | Human Computer Interaction | Computer Vision             | Augmented and Virtual Reality         | Game Theory and Application          |
| Client side Technologies and frameworks | Software Defined Network   | Server Side Technologies    | Full stack Web Development Frameworks | Data and Information security        |
| Cryptography                            | Cyber Security             | Data Privacy and ethics     | Block Chain Technology                | Digital Forensic And Threat Analysis |

**L: Lecture, P: Practical, Tut: Tutorial, ISE: In-Semester Examination, CIE: Continuous Internal Evaluation, ESE: End-Semester Examination, TW:Term work, PR: Practical Examination, OR: Oral Examination .**

**#:** Tutorial or laboratory as applicable. L, P, and T

[Refer Annexure-1](#) for MDM details.

**\*: Open elective (OE) offered by online platforms such as SWAYAM/NPTEL, [Refer Annexure-II](#) for details.**

**Annexure -2**

Guidelines for Open elective Courses

Open Elective – I will be offered in the third semester as foreign language as prescribed in the structure.

Open Electives – II, III, IV will be offered through SWAYAM/NPTEL MOOCs of Equivalent Credits.

|     |                |                                   | Teaching Scheme<br>(Hours/Week) |   |   |       | Credits |   |   |       | Examination Scheme and Marks |      |      |           |     |    |       |
|-----|----------------|-----------------------------------|---------------------------------|---|---|-------|---------|---|---|-------|------------------------------|------|------|-----------|-----|----|-------|
| Sem | Course<br>code | Name of the<br>Course             | L                               | P | T | Total | L       | P | T | Total | Theory                       |      |      | Practical |     |    | Total |
|     |                |                                   |                                 |   |   |       |         |   |   |       | CIE                          | ISE  | ESE  | CIE       | ESE |    |       |
|     |                |                                   |                                 |   |   |       |         |   |   |       | [20]                         | [20] | [60] | TW        | P   | OR |       |
| 3   | OE-I           | Foreign Language<br>Studies (FLS) | -                               | - | 2 | 2     | -       | - | 2 | 2     | -                            | -    | -    | 50        | -   | -  | 50    |
| 4   | OE-II          | MOOCs                             | -                               | - | 2 | 2     | -       | - | 2 | 2     | -                            | -    | 50   | -         | -   | -  | 50    |
| 5   | OE-III         | MOOCs                             | -                               | - | 2 | 2     | -       | - | 2 | 2     | -                            | -    | 50   | -         | -   | -  | 50    |
| 6   | OE-IV          | MOOCs                             | -                               | - | 2 | 2     | -       | - | 2 | 2     | -                            | -    | 50   | -         | -   | -  | 50    |

Departments will prepare the baskets/list of courses to be offered at the start of every semester, Students may choose any one course from the basket with adhering to any one stream.

The department shall appoint a faculty mentor to ensure monitoring and course registration smoothly. The load for faculty should be reflected in the time table.

Equivalent Teaching Scheme, credits and examination schemes are detailed in table below.

**End semester Evaluation:** No separate examination is conducted by the institute.

**Third Year B-Tech**  
**(T. Y. B. Tech)**  
**Semester-5**

**Third Year B. Tech (T. Y B. Tech) AY (2026-27)****Computer Engineering (CE)****[2615PC11]: Computer Networks (CN)**

| Semester | Credits | Teaching Scheme | Examination Scheme                              |
|----------|---------|-----------------|-------------------------------------------------|
| 5        | 2       | L: 02 Hrs./week | CIE: 20 Marks<br>ISE: 20 Marks<br>ESE: 60 Marks |

**Prerequisite:** Students should have prior knowledge of

- Graph theory, Digital Electronics

**Course Objectives:** The objective of this course is to provide students with

- Fundamentals of Computer wired and wireless networks.
- Addressing and Routing strategies in Network Layer
- Principles and protocols of Application & Transport Layer
- Explore Wireless and Mobile Communication Systems

**Course Outcomes:** After completing this course, students will be able to:

**CO1:** Apply line coding techniques and link layer protocols to ensure efficient data transmission under defined physical constraints.

**CO2:** Design network or subnetwork using routing protocols to ensure efficient inter-domain and intra-domain data delivery.

**CO3:** Select suitable transport protocols (TCP/UDP) to ensure reliable, scalable, and standards-compliant data transport.

**CO4:** Compare wireless architectures using cellular and IEEE 802.11 standards to ensure seamless mobility and secure connectivity.

**COURSE CONTENTS**

| Module I                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Physical and Data link layer         | 8 Hrs. |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------|--------|
| Introduction to Computer networks, Types of Networks, Network Terminologies, Network Models (OSI, TCP/IP), Physical Media Overview, Future of Computer Networks, Spread Spectrum Techniques, Network Devices, wireless communication, Transmission Modes: Parallel & Serial, Line Encoding Techniques: Manchester, Differential Manchester, Transmission Media, data link layer services, MAC, logical link control, flow control, error control, PPP, HDLC, IEEE 802.15 |                                      |        |
| Module II                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Network Layer and Routing Principles | 6 Hrs. |
| Network Layer Services: Connection-Oriented vs Connectionless, Internet Protocol (IP): Addressing, Subnetting, Supernetting / Route Aggregation, IPv6 Overview, NAT, Routing Fundamentals: Static vs Dynamic Routing, Routing Algorithms: Distance Vector, Link State, RIP : Basics, Metrics, Timers, Limitations, OSPF, BGP, Inter-AS vs Intra-AS Routing, MANET                                                                                                        |                                      |        |
| Module III                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Transport Layer Services & Protocols | 6 Hrs. |
| Transport Layer Overview & Services, Multiplexing/Demultiplexing, Reliability, UDP vs TCP – Detailed Overview, Socket Programming Concept, Flow Control, TCP Congestion Control Mechanisms, case studies                                                                                                                                                                                                                                                                 |                                      |        |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                   |               |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------|---------------|
| on TCP/UDP Communication,                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                   |               |
| <b>Module IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>Application Layer Services &amp; Protocols</b> | <b>6 Hrs.</b> |
| Application Layer Principles, Client-Server Model: Roles, Sockets, Request/Response, Peer-to-Peer Model: Advantages, Scalability, Examples, Application Design Issues, Protocols: (HTTP, FTP, DNS, Email, SMTP, POP3, IMAP, MIME)                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                   |               |
| <b>Text Books:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                   |               |
| <b>T1.</b> Fourauzan B, "Data Communications and Networking", 5th Edition, TataMcGrawHill Publications, ISBN:0-07-058408-7-March 2012.<br><b>T2.</b> Kurose, Ross, "Computer Networking a Top Down Approach Featuring the Internet", 9th Edition Pearson, ISBN-13 : 978-0135415535.                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                   |               |
| <b>Reference Books:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                   |               |
| <b>R1.</b> Andrew S. Tanenbaum, "Computer Networks", 6th Edition, Pearson India, 6th Edition-December 2010 ISBN 978- 0-13-676405-2.<br><b>R2.</b> L.Peterson and B. Davie, "Computer Networks: A Systems Approach", 5th Edition, Morgan-Kaufmann-April 2011 ISBN-13978-0123850591<br><b>R3.</b> Olifer & Olifer , "Computer Networks-principles, technologies & protocols for network design", student Edition WILEY, ISBN-13 : 978-8126509171<br><b>R4.</b> William Stallings, "Data and Computer Communications" , PEARSON, Eighth Edition-August 2006 ISBN-13978-9332586932.<br><b>R5.</b> Vijay K. Garg. 'Wireless Communications & Networking' Elsevier, Morgan Kaufmann, ISBN 978 - 81-312-1889-1 |                                                   |               |
| <b>Relevant MOOCs Courses:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                   |               |
| 1. Data communication, IIT Kharagpur, Prof. Ajit Pal, <a href="https://nptel.ac.in/courses/106105082">https://nptel.ac.in/courses/106105082</a><br>2. Wireless Communication for Everybody, Coursera, Kwang-Soon Kim, <a href="https://www.coursera.org/learn/wireless-communications">https://www.coursera.org/learn/wireless-communications</a><br>3. 5G wireless standard Design, IIT Kanpur, Prof. Rohit Budhiraja, <a href="https://nptel.ac.in/courses/117104484">https://nptel.ac.in/courses/117104484</a>                                                                                                                                                                                       |                                                   |               |
| <b>Relevant Topics for Self-study:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                   |               |
| 1. Network infrastructure of any organisation/campus.<br>2. Inter domain and Intra domain routing protocol.<br>3. Selection Criteria for Media<br>4. Digital transmission of analog signals: pulse code modulation (PCM)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                   |               |
| <b>Other Resources/Links:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                   |               |
| 1. <a href="http://vlabs.iitb.ac.in/vlabs-dev/labs_local/computer-networks/labs/explist.php">http://vlabs.iitb.ac.in/vlabs-dev/labs_local/computer-networks/labs/explist.php</a><br>2. <a href="https://ocw.mit.edu/courses/">https://ocw.mit.edu/courses/</a>                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                   |               |



**Third Year B. Tech (T. Y B. Tech) AY (2026-27)**  
**Computer Engineering (CE)**  
**[2615PC12]: Theory of Computation (TOC)**

| Semester | Credits | Teaching Scheme | Examination Scheme                            |
|----------|---------|-----------------|-----------------------------------------------|
| 5        | 3       | L: 03Hrs/week   | CIE: 20Marks<br>ISE: 20 Marks<br>ESE: 60Marks |

**Prerequisite:** Students should have prior knowledge of

- Discrete Mathematics

**Course Objectives:** The objective of this course is to provide students with

- Knowledge of Finite Automata for its use in pattern matching and language recognition.
- Concepts of Context-Free Grammar for recognizing formal languages.
- Fundamentals of Push Down Automata and Turing Machine.

**Course Outcomes:** After completing this course, students will be able to:

**CO1: Design** finite automata for regular pattern matching and language recognition.

**CO2: Construct** context-free grammars for recognition and generation of formal languages.

**CO3: Develop** pushdown automata (PDA) for recognition of context-free languages up to three variables

**CO4: Design** deterministic Turing machines for solving problems in formal language theory.

**COURSE CONTENTS**

| Module I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Foundations of Formal Languages and Automata | 12 Hrs. |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|---------|
| Introduction to Formal Languages: Alphabets, Strings, Languages; Operations on Languages (union, concatenation, star). Finite Automata (FA): Deterministic Finite Automata (DFA); Non-deterministic Finite Automata (NFA); $\epsilon$ -NFA; Conversions between DFA, NFA, and $\epsilon$ -NFA; Minimization of DFA. Regular Languages: Regular Expressions and their equivalence with FA; Closure properties and decision algorithms, Pumping Lemma for Regular Languages; Myhill Nerode theorem for proving non regularity of Languages. |                                              |         |
| Module II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Context-Free Grammars                        | 9 Hrs.  |
| Context-Free Grammars (CFG): Derivations and Parse Trees; Ambiguity in CFGs; Simplification of CFG: Eliminating unit productions, useless production, useless symbols, and $\epsilon$ -productions; Normal Forms (Chomsky Normal Form and Greibach Normal Form) Closure properties of CFL, Decision properties of CFL, Chomsky Hierarchy; Pumping Lemma for CFG.                                                                                                                                                                          |                                              |         |
| Module III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Pushdown Automata and Applications           | 9 Hrs.  |
| Pushdown Automata (PDA): Formal definition and components. Acceptance by final state and empty stack. Equivalence of PDA and CFG, Deterministic vs Non-deterministic PDA, Lexical Analysis: Tokenization using regular expressions, Parsing Types: Top-down & Bottom-up Parsers.                                                                                                                                                                                                                                                          |                                              |         |

| Module IV                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Turing Machines and the Limits of Computation | 9 Hrs. |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------|--------|
| <p>Turing Machines: Formal Definition, Designing Turing Machine, Examples of simple Turing Machines (e.g., recognizing palindromes, binary addition), Step-by-step design and state diagram representation. Turing-recognizable (recursively enumerable) languages, Turing-decidable (recursive) languages. Variants. Halting Problem. Undecidability and Limits of Computation: Halting Problem, Reduction technique, Rice's Theorem, and Gödel's Incompleteness Theorem—concept and significance in computability theory.</p>                                                                                                                                                                                                                                                                                                                                  |                                               |        |
| <b>Text Books:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                               |        |
| <p><b>T1.</b> John E. Hopcroft, Rajeev Motwani, Jeffrey D.Ullman, Introduction to Automata Theory Languages and Computation, 2nd Edition, 2001, Addison-Wesley, ISBN 0-201-44124-1.</p> <p><b>T2.</b> Daniel Cohen, "Introduction to Computer Theory", 2nd edition, 1996, Wiley and Sons, ISBN 97881265133454</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                               |        |
| <b>Reference Books:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                               |        |
| <p><b>R1.</b> John Martin , Introduction to Languages of The Theory of Computation, 2nd Edition, 1997, Mc Graw Hill Education, ISBN-13: 978-1-25-900558-9</p> <p><b>R2.</b> Sanjeev Arora and Boaz Barak, Computational Complexity: A Modern Approach, 1st edition, 2009, Cambridge University Press, ISBN:0521424267 9780521424264</p> <p><b>R3.</b> J. Carroll &amp; D Long , Theory of Finite Automata, Prentice Hall,1 edition, 2009, ISBN 0-13-913708-4</p> <p><b>R4.</b> Kavi Mahesh ,Theory of Computation: A Problem-Solving Approach, 1 edition, 2012, Wiley India, ISBN10 8126533110</p> <p><b>R5.</b> Michael Sipser, Introduction to the Theory of Computation, 3rd edition, 2012, Cengage Learning, ISBN-13: 9781133187813</p> <p><b>R6.</b> Vivek Kulkarni, Theory of Computation,1st edition, 2013, Oxford University Press, ISBN 0-19-808458</p> |                                               |        |
| <b>Relevant MOOCs Courses:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                               |        |
| <p>1. Theory of Computation, IIT Kanpur, Prof Raghunath Tewari<br/> <a href="https://nptel.ac.in/courses/106104148">https://nptel.ac.in/courses/106104148</a></p> <p>2. Theory of Computation, IIT Hyderabad, Prof Subrahmanyam<br/> <a href="https://nptel.ac.in/courses/106106242">https://nptel.ac.in/courses/106106242</a></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                               |        |
| <b>Relevant Topics for Self-study:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                               |        |
| Recursively Enumerable Languages, Parsing Types.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                               |        |
| <b>Other Resources/Links:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                               |        |
| Syntax Tree Generator <a href="https://mshang.ca/syntree/">https://mshang.ca/syntree/</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                               |        |



| Third Year B. Tech (T. Y B. Tech) AY (2026-27)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                         |                 |                                                 |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------|-----------------|-------------------------------------------------|
| Computer Engineering (CE)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                         |                 |                                                 |
| [2615PC13]: Artificial Intelligence (AI)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                         |                 |                                                 |
| Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Credits                                                 | Teaching Scheme | Examination Scheme                              |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 3                                                       | L: 03 Hrs/week  | CIE: 20 Marks<br>ISE: 20 Marks<br>ESE: 60 Marks |
| <b>Prerequisite: Students should have prior knowledge of</b> <ul style="list-style-type: none"><li>Discrete Mathematics, Data Structures, and basic programming</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                         |                 |                                                 |
| <b>Course Objectives: The objective of this course is to provide students with</b> <ul style="list-style-type: none"><li>Fundamentals of Artificial Intelligence and Knowledge of problem-solving techniques, and search strategies.</li><li>Knowledge representation, reasoning, and decision-making processes.</li><li>Information on designing AI agents for adversarial environments and planning problems.</li><li>Fundamentals of Machine learning methods and its application to solve real life problems.</li></ul>                                                                                                                                |                                                         |                 |                                                 |
| <b>Course Outcomes: After completing this course, students will be able to:</b><br><b>CO1: Compare</b> different search strategies and problem-solving methods based on time complexity, space complexity and completeness.<br><b>CO2: Examine</b> various search algorithms to determine their effectiveness and efficiency in solving different computational problems.<br><b>CO3: Evaluate</b> the performance and effectiveness of game-playing agents developed using adversarial search and constraint satisfaction techniques in various scenarios.<br><b>CO4: Select</b> suitable algorithms to effectively solve given machine learning problems. |                                                         |                 |                                                 |
| COURSE CONTENTS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                         |                 |                                                 |
| Module I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Introduction to AI and Critical Problem Solving         |                 | 12 Hrs.                                         |
| Introduction to AI: Evolution of AI, Applications, Benefits and Challenges, Foundations of AI, Intelligent Agents: Agents and environments, Structure of agents, Rationality, Nature of environments, Solving using Search: Problem formulation, State space, Uninformed Search Strategies: BFS, DFS, Informed Search: Heuristic functions, Greedy Search, A* Beyond Classical Search: Local Search Algorithms: Hill Climbing, Simulated Annealing, Optimization Problems, Local Search in Continuous Spaces. Case Study: Toy Games.                                                                                                                       |                                                         |                 |                                                 |
| Module II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Constraint Satisfaction Problems and Adversarial Search |                 | 9 Hrs.                                          |
| Constraint Satisfaction Problems (CSPs): Definition, Backtracking, Forward Checking, Heuristics for CSP. Adversarial Search and games: Optimal decisions in games, Min-Max                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                         |                 |                                                 |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                            |               |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|---------------|
| Algorithm, Heuristic Evaluation Functions, Alpha-Beta Pruning, Problem solving in Deterministic and Non-Deterministic Domains                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                            |               |
| <b>Module III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>Reasoning, Planning</b> | <b>9 Hrs.</b> |
| Reasoning Under Uncertainty: Need for uncertainty handling, Bayesian Networks: Structure, Conditional Independence, Inference in Bayesian Networks. Classical Planning: Planning as State Space Search, STRIPS Representation, Forward and Backward Planning. Advanced Planning Techniques: Hierarchical Task Networks (HTN), Planning and Acting in Non-Deterministic Domains, Contingency and Probabilistic Planning, Multi-Agent Planning Concepts.                                                                                                                                                                                                                                                                                                                                                                              |                            |               |
| <b>Module IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>Learning Methods</b>    | <b>9 Hrs.</b> |
| Types of Human Learning (Cognitive Learning Approaches), General Learning Model, Performance Measures of Learning Systems, Types of Machine Learning, Supervised Learning: Linear Regression, Logistic Regression, Decision Trees, Unsupervised Learning: K-Means Clustering, Principal Component Analysis (PCA), Semi-Supervised Learning: Pseudo Labeling Algorithm, Label Propagation Algorithm, Ensemble Learning, Reinforcement Learning: Markov Decision Processes (MDP), Bellman Equations, Value Function & Policy Function, Q-Learning.                                                                                                                                                                                                                                                                                    |                            |               |
| <b>Text Books:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                            |               |
| <b>T1.</b> S. Russell and P. Norvig, <i>Artificial Intelligence: A Modern Approach</i> , 4th ed. Noida, India: Pearson Education, 2022. ISBN: 9356063575.<br><b>T2.</b> E. Rich and K. Knight, <i>Artificial Intelligence</i> , 3rd ed. New Delhi, India: Tata McGraw-Hill, 2009. ISBN-0071008942.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                            |               |
| <b>Reference Books:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                            |               |
| <b>R1.</b> D. L. Poole and A. K. Mackworth, <i>Artificial Intelligence: Foundations of Computational Agents</i> , 3rd ed. Cambridge, U.K.: Cambridge University Press, 2023. ISBN: 9781009258227.<br><b>R2.</b> N. J. Nilsson, <i>Artificial Intelligence: A New Synthesis</i> . San Francisco, CA, USA: Morgan Kaufmann, Apr. 1998. ISBN: 1558604677.<br><b>R3.</b> D. Khemani, <i>A First Course in Artificial Intelligence</i> . New Delhi, India: McGraw-Hill Education, Jul. 2017. ISBN: 1259029980, 9781259029981.                                                                                                                                                                                                                                                                                                            |                            |               |
| <b>Relevant MOOCs Courses:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                            |               |
| 1. An Introduction to Artificial Intelligence by Prof. Mausam, from IIT Delhi <a href="https://onlinecourses.nptel.ac.in/noc22_cs56/preview">https://onlinecourses.nptel.ac.in/noc22_cs56/preview</a><br>2. Artificial Intelligence by Prof. Deepak Khemani <a href="http://www.digimat.in/nptel/courses/video/106106126/L01.html">http://www.digimat.in/nptel/courses/video/106106126/L01.html</a><br>3. Artificial Intelligence: Concepts and Techniques by Prof. V. Susheela Devi, from IISc Bangalore <a href="https://onlinecourses.nptel.ac.in/noc25_cs159/preview">https://onlinecourses.nptel.ac.in/noc25_cs159/preview</a><br>4. Artificial Intelligence, IIT Kharagpur by Prof. Anupam Basu, Prof. S. Sarkar from IIT Kharagpur <a href="https://nptel.ac.in/courses/106105077">https://nptel.ac.in/courses/106105077</a> |                            |               |
| <b>Relevant Topics for Self-study:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                            |               |
| Search Algorithms and Heuristics Search                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                            |               |



| <b>Third Year B. Tech (T. Y B. Tech) AY (2026-27)</b><br><b>Computer Engineering (CE)</b><br><b>[2615PC31]: Computer Networks Laboratory (CNL)</b>                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                        |                 |                                        |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|----------------------------------------|
| Semester                                                                                                                                                                                                                                                                                                                                                                                                                                        | Credits                                                                                                                                                                                                                                                                                                | Teaching Scheme | Examination Scheme                     |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                               | 1                                                                                                                                                                                                                                                                                                      | P: 02 Hrs./week | CIE(TW): 25 Marks<br>ESE(OR): 25 Marks |
| <b>Prerequisite: Students should have prior knowledge of</b> <ul style="list-style-type: none"> <li>Discrete Mathematics, Data Communication</li> </ul>                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                        |                 |                                        |
| <b>Course Objectives: The objective of this course is to provide students with</b> <ul style="list-style-type: none"> <li>The concept of computer network topologies and types of network.</li> <li>The concept of error detection and correction for transmission of data.</li> <li>Fundamentals of modern tools for network traffic analysis and simulation.</li> </ul>                                                                       |                                                                                                                                                                                                                                                                                                        |                 |                                        |
| <b>Course Outcomes: After completing this course, students will be able to</b><br><b>CO1: Demonstrate</b> network types, topology and transmission media using Cisco Packet Tracer.<br><b>CO2: Analyze</b> error control, flow control techniques and protocols.<br><b>CO3: Analyze</b> the performance of routing protocols (RIP/OSPF/BGP) using Cisco packet tracer.<br><b>CO4: Develop</b> Client-Server application using TCP/UDP protocol. |                                                                                                                                                                                                                                                                                                        |                 |                                        |
| List of Assignments                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                        |                 |                                        |
| Sr. No                                                                                                                                                                                                                                                                                                                                                                                                                                          | Problem Statement                                                                                                                                                                                                                                                                                      | COs             |                                        |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                               | LAN Setup and Packet Analysis with Network Command Testing & File Transmission: To design and configure a Local Area Network (LAN), analyze network traffic using wireshark packet analyzer tool, test connectivity with standard network commands, and demonstrate file transmission between systems. | CO1             |                                        |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                               | Implement error detection and correction techniques by using Hamming Codes (for single-bit error correction) and/or Cyclic Redundancy Check (CRC) (for error detection), and to verify their working through simulation or program output                                                              | CO2             |                                        |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                               | Design a multi-router network in Cisco Packet Tracer and configure RIP/OSPF/ BGP routing protocols. After configuration, test network connectivity and verify routing                                                                                                                                  | CO3             |                                        |

|          |                                                                                                                                                                      |         |
|----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|
|          | behavior                                                                                                                                                             |         |
| <b>4</b> | Implement TCP (connection-oriented) and UDP (connectionless) client-server applications (e.g any chat application, Multimedia data transmission)                     | CO4     |
| <b>5</b> | Mini Project: Design and implement a simulated campus network that demonstrates end-to-end data communication, transport reliability, routing, and wireless mobility | CO3-CO4 |



| Third Year B. Tech (T. Y B. Tech) AY (2026-27)<br>Computer Engineering (CE)<br>[2615PC32]: Artificial Intelligence Lab (AIL)                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                   |                                          |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|------------------------------------------|
| Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Credits                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Teaching Scheme   | Examination Scheme                       |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | P: 02<br>Hrs/week | CIE(TW) : 25 Marks<br>ESE(PR) : 25 Marks |
| <b>Prerequisite:</b> Students should have prior knowledge of <ul style="list-style-type: none"><li>Discrete Mathematics, Data Structures, basic programming</li></ul>                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                   |                                          |
| <b>Course Objectives:</b> The objective of this course is to provide students with <ul style="list-style-type: none"><li>Knowledge of problem-solving techniques including uninformed and informed search strategies.</li><li>Knowledge representation, reasoning (deterministic and uncertain), and decision-making processes.</li><li>Information on designing AI agents for adversarial environments and planning problems.</li><li>AI techniques to apply in real-world and multi-agent systems.</li></ul> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                   |                                          |
| <b>Course Outcomes:</b> After completing this course, students will be able to<br><b>CO1: Implement</b> appropriate search algorithms to solve computational problems.<br><b>CO2: Develop</b> game-playing agents using adversarial search and constraint satisfaction techniques.<br><b>CO3: Design</b> AI-based planning solutions for classical, hierarchical, and nondeterministic domains.<br><b>CO4: Implement</b> appropriate learning algorithms to solve the given machine learning problems.         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                   |                                          |
| List of Assignments                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                   |                                          |
| Sr.No.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Problem Statement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | COs               |                                          |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Design a system to find the shortest path between two locations, similar to Google Maps. Design with uninformed search algorithm and informed search algorithm and analyse the result. Create a graph of at least 8–10 cities/nodes<br>Define: Distance between nodes (edge cost) Heuristic values (straight-line distance to goal)<br>OR<br>Solve the problem of arranging the tiles on N*N board. The tiles are numbered from 1 to N <sup>2</sup> -1 with one vacant space. The goal is to rearrange the tiles (by sliding them into empty spaces) until the board matches the target configuration. Design and implement the most suitable algorithm to solve the given problem. | CO1               |                                          |

|          |                                                                                                                                                                                                                                                                                                                                                                      |            |
|----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>2</b> | Implement Smart Parking Allocation. Assign parking slots based on constraints<br>Similar to systems used in smart cities<br>OR<br>Design an intelligent agent to play a game (e.g., Tic-Tac-Toe) using Minimax with Alpha-Beta Pruning to make optimal decisions. .                                                                                                  | <b>CO2</b> |
| <b>3</b> | Design an intelligent traffic control system that dynamically adjusts signal timings based on uncertain traffic conditions at intersections.<br>OR<br>Implement the Map Coloring problem for Indian states/any country/region mapping using CSP.                                                                                                                     | <b>CO2</b> |
| <b>4</b> | Consider a labeled dataset (for example, customer churn data, health records, or housing prices). Implement models to predict the target outcome (e.g., churn or price) using supervised, semisupervised, and ensemble methods. Evaluate and compare their performance.<br>OR<br>Develop an AI agent that learns to play a simple game using reinforcement learning. | <b>CO3</b> |
| <b>5</b> | Mini Project (Any one):<br>1) Credit Card Fraud Detection Problem: Identify fraudulent transactions using anomaly detection. Dataset: Credit Card Fraud Detection (Kaggle).<br>2) AI Resume Parser Problem: Automatically extract information from resumes (name, skills, experience) Tools: NLP libraries like spaCy, PDF parser                                    | <b>CO4</b> |



| Third Year B. Tech (T. Y B. Tech) AY (2026-27)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                         |                 |                                                 |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|-----------------|-------------------------------------------------|
| Computer Engineering (CE)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                         |                 |                                                 |
| [2615PE11]: Data Warehousing and Mining (DWM)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                         |                 |                                                 |
| Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Credits                                 | Teaching Scheme | Examination Scheme                              |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 3                                       | L: 03 Hrs./week | CIE: 20 Marks<br>ISE: 20 Marks<br>ESE: 60 Marks |
| <b>Prerequisite: Students should have prior knowledge of</b> <ul style="list-style-type: none"><li>Database Management System, Basic Mathematics</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                         |                 |                                                 |
| <b>Course Objectives: The objective of this course is to provide students with</b> <ul style="list-style-type: none"><li>Fundamental concepts of statistical measures, similarity/dissimilarity metrics, and preprocessing methods for data analysis and preparation.</li><li>Knowledge of Architecture and models of data warehousing, OLAP operations for decision support.</li><li>Explore various algorithms in data mining.</li></ul>                                                                                                                                                                                                                                                                                                                                                                           |                                         |                 |                                                 |
| <b>Course Outcomes: After completing this course, students will be able to:</b><br><b>CO1: Choose</b> suitable data preprocessing techniques for the given problems<br><b>CO2: Construct</b> a data warehouse and use OLAP operations<br><b>CO3: Formulate</b> association rules by finding frequent patterns.<br><b>CO4: Select</b> classification and clustering techniques to solve given problems.                                                                                                                                                                                                                                                                                                                                                                                                               |                                         |                 |                                                 |
| COURSE CONTENTS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                         |                 |                                                 |
| Module I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Data Understanding and Data Preparation |                 | 12 Hrs.                                         |
| Data: Data, Information and Knowledge; Data Objects and Attribute Types: Introduction. Nominal Attributes, Binary Attributes, Ordinal Attributes, Numeric Attributes, Discrete versus Continuous Attributes, Measuring the Central Tendency: Mean, Median, and Mode, Measuring the Dispersion of Data: Range, Quartiles, Variance, Standard Deviation, and Interquartile Range, Graphic Displays of Basic Statistical Descriptions of Data, Data Visualization, Measuring Data Similarity and Dissimilarity, Data Preprocessing overview, Data Cleaning: Missing Values, Noisy Data, Data Cleaning as a Process, Data Integration: Entity Identification Problem, Redundancy and Correlation Analysis, Tuple Duplication, Data Value Conflict Detection and Resolution, Data Transformation and Data Discretization. |                                         |                 |                                                 |
| Module II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Data Warehousing                        |                 | 9 Hrs.                                          |
| Introduction, Differences between Operational Database Systems and Data Warehouses, Need for Separate Data Warehouse, A Multitiered Architecture, Data Warehouse Models: Enterprise Warehouse, Data Mart, and Virtual Warehouse, Extraction, Transformation, and Loading, Metadata Repository, A Multidimensional Data Model: Data Cubes, Stars, Snowflakes, and Fact Constellations Schemas, Dimensions; OLAP Operations in the Multidimensional Data Model, Concept Hierarchies, Types of OLAP Servers: ROLAP versus MOLAP versus HOLAP. Case Study: Study of ETL tools                                                                                                                                                                                                                                            |                                         |                 |                                                 |

| Module III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Data Mining and Association Rules Mining | 9 Hrs. |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------|--------|
| Data Mining: Introduction, what kind of data can be mined, Applications, Techniques used for data mining, and Major Issues. Association Rule Mining: Market Basket Analysis, Frequent item set, Closed item set, Association Rules, Apriori Algorithm, Generating Association Rules from Frequent Item sets, Improving the Efficiency of Apriori, Mining Frequent Item sets without Candidate Generation: FP Growth Algorithm; Mining Various Kinds of Association Rules: Mining multilevel association rules, constraint-based association rule mining |                                          |        |
| Module IV                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Classification and Clustering            | 9 Hrs  |
| Classification: Decision Tree Induction, Naive Bayesian Classification, Support Vector Machines, k-Nearest-Neighbor Classifiers, Ensemble methods, Model Evaluation and Selection, Clustering: Partitioning Methods, Hierarchical Methods, Density-Based Methods, Evaluation, Outlier Detection Methods                                                                                                                                                                                                                                                 |                                          |        |
| <b>Text Books:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                          |        |
| <b>T1.</b> J. Han, M. Kamber, and J. Pei, <i>Data Mining: Concepts and Techniques</i> , 3rd ed. Waltham, MA, USA: Elsevier, 2012. ISBN: 9780123814791.<br><b>T2.</b> M. H. Dunham, <i>Data Mining: Introductory and Advanced Topics</i> , 1st ed. New Delhi, India: Pearson Education India, Jan. 2006. ISBN: 8177587854.                                                                                                                                                                                                                               |                                          |        |
| <b>Reference Books:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                          |        |
| <b>R1.</b> G. K. Gupta, <i>Introduction to Data Mining with Case Studies</i> , 2nd ed. New Delhi, India: PHI Learning Pvt. Ltd., 2011. ISBN: 978-81-203-4326-9.<br><b>R2.</b> P.-N. Tan, M. Steinbach, and V. Kumar, <i>Introduction to Data Mining</i> , 1st ed. New Delhi, India: Pearson Education, 2007. ISBN: 9332571406.                                                                                                                                                                                                                          |                                          |        |
| <b>Relevant MOOCs Courses:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                          |        |
| 1. Data Mining, IIT Kharagpur Prof. Pabitra Mitra<br><a href="https://nptel.ac.in/courses/106105174">https://nptel.ac.in/courses/106105174</a><br>2. Introduction to Data Warehousing and Data Mining, By Dr. Vaibhav Panwar , Manipal University, Jaipur,<br><a href="https://onlinecourses.swayam2.ac.in/e-learning/preview/imb26_mg92">https://onlinecourses.swayam2.ac.in/e-learning/preview/imb26_mg92</a>                                                                                                                                         |                                          |        |
| <b>Relevant Topics for Self-study:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                          |        |
| Hierarchical clustering                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                          |        |
| <b>Other Resources/Links:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                          |        |
| 1. Weka tool <a href="https://ml.cms.waikato.ac.nz/weka/">https://ml.cms.waikato.ac.nz/weka/</a><br>2. Data Bricks <a href="https://www.databricks.com/">https://www.databricks.com/</a>                                                                                                                                                                                                                                                                                                                                                                |                                          |        |



| Third Year B. Tech (T. Y B. Tech) AY (2026-27)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                          |                 |                                                 |
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| Computer Engineering (CE)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                          |                 |                                                 |
| [2615PE12]: File Systems Design and Rust Programming (FSRP)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                          |                 |                                                 |
| Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Credits                                  | Teaching Scheme | Examination Scheme                              |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 3                                        | L: 03 Hrs./week | CIE: 20 Marks<br>ISE: 20 Marks<br>ESE: 60 Marks |
| Prerequisite: Students should have prior knowledge of <ul style="list-style-type: none"><li>Operating Systems</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                          |                 |                                                 |
| Course Objectives: The objective of this course is to provide students with <ul style="list-style-type: none"><li>Understanding of Internals of File systems.</li><li>Working of Linux File Systems.</li><li>Knowledge of Optimization methods of File Systems</li><li>Knowledge of building file systems with RUST APIs.</li></ul>                                                                                                                                                                                                                                                                                                                                                                                         |                                          |                 |                                                 |
| Course Outcomes: After completing this course, students will be able to:<br>CO1: Distinguish various file organization methods.<br>CO2: Illustrate internal representation of files in LINUX.<br>CO3: Differentiate between disk organizations methods.<br>CO4: Design file systems in Rust incorporating diverse operations and functionalities.                                                                                                                                                                                                                                                                                                                                                                           |                                          |                 |                                                 |
| COURSE CONTENTS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                          |                 |                                                 |
| Module I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Introduction to File system              |                 | 12 Hrs.                                         |
| Introduction to file system, File system design details, File operations, Directory structure,File and file system metadata, caching optimizations, File System case study (the Unix file system etc.), Persistence and the File abstraction, Hardware view: Hard disk architecture and its interfacing, Process view: System calls for file handling, Introduction to Distributed file system, Access control and protection                                                                                                                                                                                                                                                                                               |                                          |                 |                                                 |
| Module II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Linux File System                        |                 | 09 Hrs.                                         |
| Introduction to Linux File Systems: Role and importance of file systems in Linux, Overview of file system functions: storing, organizing, managing data. Internal representation of files: Inodes, Structure of a regular file, Directories, Conversion of a path name to an inode, Super block, Inode assignment to a new file, Allocation of disk blocks. Types of Linux File Systems: Ext4 (Fourth Extended File System), Btrfs (B-tree File System), XFS, ZFS (Zettabyte File System), Other Linux File Systems: Reiser4, SquashFS. Case Studies and Practical Applications: Default file system selection in popular Linux distros, Use cases for different file systems (e.g., Btrfs for snapshots, XFS for big data) |                                          |                 |                                                 |
| Module III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | File System Performance and Optimization |                 | 09 Hrs.                                         |
| File System Performance Strategies, Metrics of File System Performance, Journaling and crash recovery, Caching mechanisms and buffering, Impact of file system choice on performance, File                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                          |                 |                                                 |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                      |                |
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| systems performance tuning, Optimizing performance example, Disk Performance and I/O Management, Disk scheduling algorithms (FCFS, SSTF, SCAN, C-SCAN, LOOK, C-LOOK), File System Caching, Data Layout and Access Optimization, File Allocation and Free Space Management Optimization.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                      |                |
| <b>Module IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>File system design using RUST</b> | <b>09 Hrs.</b> |
| Introduction to RUST: Why Rust for file system development: safety, concurrency, performance, Rust Fundamentals for Systems Programming , Building Blocks: Rust Data Structures and Modules for File Systems , Error Handling and Fault Tolerance in Rust File Systems , Implementing Basic File System Operations, Persistence and Storage Management, Building Blocks: Rust Data Structures and Modules for File Systems ,Interacting with the OS File System:, Building a Custom File System (Lower-Level), Block Devices, Inodes and Data Blocks, File System Structures, Concurrency and Atomicity, FUSE (Filesystem in Userspace)                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                      |                |
| <b>Text Books:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                      |                |
| <b>T1.</b> M. J. Bach, <i>The Design of the UNIX Operating System</i> . Englewood Cliffs, NJ, USA: Prentice Hall, 1986. ISBN: 978-8120305168.<br><b>T2.</b> A. Silberschatz, P. B. Galvin, and G. Gagne, <i>Operating System Concepts</i> , 10th ed. Hoboken, NJ, USA: Addison-Wesley, 2021. ISBN: 978-1119800361.<br><b>T3.</b> S. Klabnik and C. Nichols, <i>The Rust Programming Language</i> , 2nd ed. San Francisco, CA, USA: No Starch Press, Dec. 2022. ISBN: 9781718503106.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                      |                |
| <b>Reference Books:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                      |                |
| <b>R1.</b> A. S. Tanenbaum and H. Bos, <i>Modern Operating Systems</i> , 5th ed. Hoboken, NJ, USA: Pearson, 2022. ISBN: 978-0-13-761887-3.<br><b>R2.</b> J. Blandy, J. Orendorff, and L. F. S. Tindall, <i>Programming Rust: Fast, Safe Systems Development</i> . Sebastopol, CA, USA: O'Reilly Media, 2021. ISBN: 978-1-4920-5259-3.<br><b>R3.</b> P. Eshwarla, <i>Practical System Programming for Rust Developers: Build Fast and Secure Software for Linux/Unix Systems with Practical Examples</i> , 1st ed. Birmingham, U.K.: Packt Publishing, 2020. ISBN: 1800560966.<br><b>R4.</b> Dargslan, <i>Linux File Systems Explained: ext4, Btrfs, XFS, and ZFS Compared</i> . 2025. [Online]. Available: <a href="https://www.kobo.com/ie/en/ebook/linux-file-systems-explained-ext4-btrfs-xfs-and-zfs-compared">https://www.kobo.com/ie/en/ebook/linux-file-systems-explained-ext4-btrfs-xfs-and-zfs-compared</a><br><b>R5.</b> W. Stallings, <i>Operating Systems: Internals and Design Principles</i> , 9th ed. Hoboken, NJ, USA: Pearson, 2018. ISBN: 978-0134670959. |                                      |                |
| <b>Relevant MOOCs Courses:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                      |                |
| 1. Storage Systems By Dr. K. Gopinath-IISc Bangalor<br><a href="https://nptel.ac.in/courses/106108058">nptel.ac.in/courses/106108058</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                      |                |
| <b>Relevant Topics for Self-study:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                      |                |
| Google File System, Windows File Systems, Libraries etc                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                      |                |
| <b>Other Resources/Links:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                      |                |
| 1. <a href="https://systemdesignschool.io/blog/linux-file-systems">https://systemdesignschool.io/blog/linux-file-systems</a><br>2. <a href="https://web.cs.ucla.edu/classes/winter13/cs111/scribe/10c/">https://web.cs.ucla.edu/classes/winter13/cs111/scribe/10c/</a><br>3. <a href="https://www.ibm.com/docs/en/aix/7.1.0?topic=performance-file-system-tuning">https://www.ibm.com/docs/en/aix/7.1.0?topic=performance-file-system-tuning</a><br>4. <a href="https://www.rust-lang.org/">https://www.rust-lang.org/</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                      |                |



| Third Year B. Tech (T. Y B. Tech) AY (2026-27)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                             |                 |                                                 |
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| Computer Engineering (CE)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                             |                 |                                                 |
| [2615PE13]: Computer Graphics (CG)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                             |                 |                                                 |
| Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Credits                                     | Teaching Scheme | Examination Scheme                              |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 3                                           | L: 03 Hrs./week | CIE: 20 Marks<br>ISE: 20 Marks<br>ESE: 60 Marks |
| <b>Prerequisite: Students should have prior knowledge of</b> <ul style="list-style-type: none"><li>Object Oriented Programming and Data Structures, Basics of Linear Algebra</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                   |                                             |                 |                                                 |
| <b>Course Objectives: The objective of this course is to provide students with</b> <ul style="list-style-type: none"><li>Knowledge of 2D and 3D geometrical transformations</li><li>Knowledge of drawing, clipping and filling 2D objects with algorithms</li><li>The concepts of curves, fractals</li><li>Concepts related to animation and game design</li></ul>                                                                                                                                                                                                                       |                                             |                 |                                                 |
| <b>Course Outcomes: After completing this course, students will be able to:</b><br><b>CO1: Select</b> techniques for representing 2D and 3D geometrical objects and its geometrical transformations with viewing.<br><b>CO2: Apply</b> algorithms to rasterize simple 2D graphics with lines, and different shapes, fill and clip 2D graphics.<br><b>CO3: Illustrate</b> the concept of Bezier, B-Spline curves, fractals such as Hilbert and Triadic curves.<br><b>CO4: Analyze</b> animation and gaming methods to enhance program effectiveness.                                      |                                             |                 |                                                 |
| COURSE CONTENTS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                             |                 |                                                 |
| Module I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Graphics Primitives and Transformations     |                 | 12 Hrs.                                         |
| Introduction to Graphics, Basic Terminologies: Pixel, Aspect Ratio, Resolution, frame buffer, rasterization, scan conversion, raster vs vector scan. Transformations: Matrix representation of points, 2 dimensional Translations and Homogeneous Coordinates, Rotation, Reflection, Scaling, and shearing, Window-to-Viewport Transformations, 3D translation – rotation, scaling and shearing - composite transformation - viewing pipeline and coordinates - parallel and perspective transformation - view volume and general (parallel and perspective) projection transformations. |                                             |                 |                                                 |
| Module II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Solid Area Scan Conversion                  |                 | 9 Hrs.                                          |
| Scan Conversion of Polygons, Inside Test, Filling Polygons: Seed fill, Scan Line, Clipping Lines algorithms– Cohen-Sutherland, 2D Polygon Clipping Algorithms: Sutherland Hodgeman, Weiler Atherton, 3D Clipping. OpenGL Primitives: Architecture, Libraries, Functions, Rendering 2-D and 3-D objects, Shaders, Textures and lighting concepts(Illumination Models).                                                                                                                                                                                                                    |                                             |                 |                                                 |
| Module III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Curves, Fractals and Hidden Surface Removal |                 | 9 Hrs.                                          |
| Curve Representation, Nonparametric Curves, Parametric Curves, Interpolation and approximation, Representation of Space Curves, Bezier Curves, Cubic Splines, B-spline Curves, Polygonal Meshes and glDrawArrays. Fractals: Introduction, Classification, Generation of fractal: Hilbert, Koch, Applications                                                                                                                                                                                                                                                                             |                                             |                 |                                                 |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                             |               |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|---------------|
| of Fractal. Hidden Surface Removal: Back-Face Removal, Z-Buffer Algorithm (Depth Buffering), Painter's Algorithm, Scanline Algorithm, Binary Space Partitioning, Area sub-division method                                                                                                                                                                                                                                                                                                                                                                                                     |                             |               |
| <b>Module IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <b>Animation and Gaming</b> | <b>9 Hrs.</b> |
| <p>Animation: Introduction, Principles of animation, Design of Animation Sequences, Traditional and Computer based animation, Motion Specifications, Morphing, OpenGL Animation Procedures.</p> <p>Gaming: Introduction to Game Development, Game design principles, Genres and game mechanics, Physics in games (basic kinematics, collision detection), Introduction to a game engine (e.g., Unity or Unreal Engine).</p>                                                                                                                                                                   |                             |               |
| <b>Text Books:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                             |               |
| <p><b>T1.</b> D. D. Hearn and M. P. Baker, <i>Computer Graphics with OpenGL</i>, 4th ed. Upper Saddle River, NJ, USA: Pearson, 2011. ISBN: 9780136053583.</p> <p><b>T2.</b> D. F. Rogers, <i>Procedural Elements for Computer Graphics</i>, 2nd ed. New Delhi, India: Tata McGraw-Hill, 2001. ISBN: 0-07-047371-4.</p> <p><b>T3.</b> J. F. Hughes, A. Van Dam, M. McGuire, D. F. Sklar, J. D. Foley, S. K. Feiner, and K. Akeley, <i>Computer Graphics: Principles and Practice</i>, 3rd ed. Noida, India: Pearson Education India, Dec. 2018. ISBN: 978-0321399526.</p>                      |                             |               |
| <b>Reference Books:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                             |               |
| <p><b>R1.</b> D. F. Rogers, <i>Mathematical Elements for Computer Graphics</i>, 2nd ed. New Delhi, India: Pearson Education, 2003. ISBN: 81-7808-038-9.</p> <p><b>R2.</b> E. Lengyel, <i>Mathematics for 3D Game Programming and Computer Graphics</i>. Hingham, MA, USA: Charles River Media, 2002. ISBN: 9781435458871.</p> <p><b>R3.</b> D. J. Eck, <i>Introduction to Computer Graphics</i>, ver. 1.4, Aug. 2023. [Online]. Available: <a href="http://math.hws.edu/eck/cs424/downloads/graphicsbook-linked.pdf">http://math.hws.edu/eck/cs424/downloads/graphicsbook-linked.pdf</a>.</p> |                             |               |
| <b>Relevant MOOCs Courses:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                             |               |
| <ol style="list-style-type: none"> <li>1. Computer Graphics by Prof. Samit Bhattacharya   IIT Guwahati<br/><a href="https://onlinecourses.nptel.ac.in/noc20_cs90/preview">https://onlinecourses.nptel.ac.in/noc20_cs90/preview</a></li> <li>2. Introduction to Computer Graphics by Prof. Prem K Kalra   IIT Delhi<br/><a href="https://nptel.ac.in/courses/106102065">https://nptel.ac.in/courses/106102065</a></li> </ol>                                                                                                                                                                   |                             |               |
| <b>Relevant Topics for Self-study:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                             |               |
| <ol style="list-style-type: none"> <li>1. GPU Architecture and how it accelerates graphics</li> <li>2. Virtual Reality (VR) and Augmented Reality (AR) basics.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                     |                             |               |
| <b>Other Resources/Links:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                             |               |
| <ol style="list-style-type: none"> <li>1. <a href="https://www.cse.iitb.ac.in/~paragc/course/2019-02-cs475/">https://www.cse.iitb.ac.in/~paragc/course/2019-02-cs475/</a></li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                          |                             |               |



| Third Year B. Tech (T. Y B. Tech) AY (2026-27)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                 |                 |                                                 |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|-----------------|-------------------------------------------------|
| Computer Engineering (CE)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                 |                 |                                                 |
| [2615PE14]: Client Side Technologies and Frameworks (CSTF)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                 |                 |                                                 |
| Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Credits                         | Teaching Scheme | Examination Scheme                              |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 3                               | L: 03 Hrs/week  | CIE: 20 Marks<br>ISE: 20 Marks<br>ESE: 60 Marks |
| <b>Pre-requisite:</b> Students should have prior knowledge of <ul style="list-style-type: none"><li>Basic knowledge of programming</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                          |                                 |                 |                                                 |
| <b>Course Objectives:</b> The objective of this course is to provide students with <ul style="list-style-type: none"><li>Fundamental knowledge of web designing.</li><li>Basics of JavaScript for client-side processing.</li><li>React.js library for front-end enhancement.</li><li>Knowledge of frameworks for rapid web development.</li></ul>                                                                                                                                                                                                                    |                                 |                 |                                                 |
| <b>Course Outcomes:</b> After completing this course, students will be able to:<br><b>CO1: Utilize</b> HTML and CSS to design web-pages.<br><b>CO2: Perform</b> web-page manipulations and form validations using JavaScript.<br><b>CO3: Identify</b> React.js library for developing interactive UI components.<br><b>CO4: Illustrate</b> the frameworks for rapid client-side development.                                                                                                                                                                          |                                 |                 |                                                 |
| COURSE CONTENTS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                 |                 |                                                 |
| Module I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Web Designing Fundamentals      |                 | 12 Hrs.                                         |
| Role of client-side in web architecture, HTTP request and response messages, web clients, web servers, Introduction to markup languages, HTML page structure. HTML5 elements: Text formatting and structuring elements, form component elements and attributes, semantic elements, media tags. CSS: Introduction to style sheet, CSS features, CSS core syntax, CSS selectors, CSS inclusion methods, style rule cascading and inheritance, shorthand CSS properties for text, background, border. Case study on use of CSS by W3Schools in its own W3.CSS framework. |                                 |                 |                                                 |
| Module II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | JavaScript and DOM Manipulation |                 | 9 Hrs.                                          |
| JavaScript: Introduction to JavaScript, JavaScript real-world applications, JavaScript basic syntax, JavaScript fundamentals concepts and core data structures, built in objects. DOM: Introduction to Document Object Model, DOM levels, the document tree, intrinsic event handling, finding HTML elements, modifying element attributes and style, DOM event handling. jQuery library: element selection, the css() method, element manipulation with jQuery, Introduction to AJAX, case study on working of AJAX with real-world applications.                    |                                 |                 |                                                 |
| Module III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | React.js Essentials             |                 | 9 Hrs.                                          |
| Introduction to React.js, component-based architecture, JSX syntax and coding constructs, rendering HTML elements with JSX, React components, conditionals, props, lists, forms, events. React Hooks- useState, useEffect, useContext, useReducer. Case study on working of any Todo list based on React.js.                                                                                                                                                                                                                                                          |                                 |                 |                                                 |

| Module IV                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Advanced Client-Side Frameworks | 9 Hrs. |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|--------|
| <p>Bootstrap: Bootstrap as a responsive front-end UI framework, CDN vs npm installation, Bootstrap page structure, bootstrap layout structure and responsive design concepts, built-in UI components-buttons, alerts, forms, navbars, cards. Next.js: Introduction to Next.js, features of Next.js, installation and project structure, routing in Next.js, creating reusable UI components. Case study on real-world application of data rendering using props.</p>                                                                          |                                 |        |
| <b>Text Books:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                 |        |
| <p><b>T1.</b> J. C. Jackson, <i>Web Technologies: A Computer Science Perspective</i>, 2nd ed. Upper Saddle River, NJ, USA: Pearson Education, 2007. ISBN: 978-0131856035.</p> <p><b>T2.</b> A. Banks and E. Porcello, <i>Learning React</i>, 2nd ed. Sebastopol, CA, USA: O'Reilly Media, 2020. ISBN: 978-1492051725.</p> <p><b>T3.</b> J. Spurlock, <i>Bootstrap: responsive web development</i>. 1st ed. Sebastopol, CA, USA: O'Reilly Media, 2013. ISBN: 9781449343910.</p>                                                                |                                 |        |
| <b>Reference Books:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                 |        |
| <p><b>R1.</b> M. Hall and L. Brown, <i>Core Web Programming</i>, 2nd ed. Upper Saddle River, NJ, USA: Pearson Education, 2001. ISBN: 978-0130897930.</p> <p><b>R2.</b> M. Riva, <i>Real-World Next.js</i>, 1st ed. Birmingham, U.K.: Packt Publishing, 2022. ISBN: 978-1801073493.</p>                                                                                                                                                                                                                                                        |                                 |        |
| <b>Relevant MOOCs Courses:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                 |        |
| <ol style="list-style-type: none"> <li>1. Web Technologies By Dr. S. Sasirekha-National Institute of Technical Teachers' Training and Research, Chennai <a href="https://onlinecourses.swayam2.ac.in/e-learning/preview/ntr26_ed79">https://onlinecourses.swayam2.ac.in/e-learning/preview/ntr26_ed79</a></li> <li>2. Web Technology By Dr. Ashutosh Kumar Bhatt-Uttarakhand Open University, Haldwani <a href="https://onlinecourses.swayam2.ac.in/nou25_cs23/preview">https://onlinecourses.swayam2.ac.in/nou25_cs23/preview</a></li> </ol> |                                 |        |
| <b>Relevant Topics for Self-study:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                 |        |
| <p>React router for single-page navigation, Bootstrap utility classes for rapid design, Deployment of Next.js applications to platforms like Vercel or Netlify, Next.js API routes for backend functionality.</p>                                                                                                                                                                                                                                                                                                                             |                                 |        |
| <b>Other Resources/Links:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                 |        |
| <ol style="list-style-type: none"> <li>1. HTML, The Complete Reference: <a href="http://www.htmlref.com/">http://www.htmlref.com/</a></li> <li>2. <a href="https://jquery.com/">https://jquery.com/</a></li> <li>3. <a href="https://getbootstrap.com">https://getbootstrap.com</a></li> <li>4. <a href="https://nextjs.org/learn">https://nextjs.org/learn</a></li> </ol>                                                                                                                                                                    |                                 |        |



| Third Year B. Tech (T. Y B. Tech) AY (2026-27)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                             |                 |                                                 |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|-----------------|-------------------------------------------------|
| Computer Engineering (CE)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                             |                 |                                                 |
| [2615PE15]: Cryptography (CGR)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                             |                 |                                                 |
| Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Credits                     | Teaching Scheme | Examination Scheme                              |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 3                           | L: 03 Hrs/week  | CIE: 20 Marks<br>ISE: 20 Marks<br>ESE: 60 Marks |
| Prerequisite: Students should have prior knowledge of                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                             |                 |                                                 |
| <ul style="list-style-type: none"><li>Basic Mathematics</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                             |                 |                                                 |
| Course Objectives: The objective of this course is to provide students with                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                             |                 |                                                 |
| <ul style="list-style-type: none"><li>Basic mathematics for cryptography, Core concepts of cryptography, and their application in securing data.</li><li>Skills to identify and analyze common security threats and vulnerabilities in networks and systems.</li><li>Knowledge of basic security measures to protect applications and software.</li><li>Basics to classify threats to assess damages to information systems</li><li>Knowledge of threats to assess damages and basic security measures to protect applications and software.</li></ul>                                                                                                                                                                                                                                                                                                                                                                                              |                             |                 |                                                 |
| Course Outcomes: After completing this course, students will be able to:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                             |                 |                                                 |
| CO1: Choose number theory concepts such as modular arithmetic, GCD algorithms, Euler’s theorem, Fermat’s theorem to solve cryptographic problems                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                             |                 |                                                 |
| CO2: Compare and contrast classical encryption techniques and justify their cryptographic strength and vulnerability to cryptanalysis                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                             |                 |                                                 |
| CO3: Design secure communication systems by integrating cryptographic primitives with authentication and hashing techniques.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                             |                 |                                                 |
| CO4: Identify real-world vulnerabilities and propose appropriate cryptographic solutions.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                             |                 |                                                 |
| COURSE CONTENTS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                             |                 |                                                 |
| Module I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Foundations of Cryptography |                 | 12 Hrs                                          |
| Mathematical background: Number Theory – Modular Arithmetic: Notations & Operations, Divisibility & Division Algorithm, Euler’s totient theorem, General formula Phi function, Euclid’s method of finding greatest common divisor (GCD), Extended Euclid’s algorithm. Computing Galois field, Factoring, Prime numbers, relative prime, Fermat’s theorem, Application of Fermat’s little theorem & congruence. Primality testing & its types, Recommended primality test. The Chinese Remainder Theorem, Discrete Logarithm. Applications of mathematics in cryptography Model of Network Security, Network Access Security Model, Security Attacks, Security Services. CIA (Confidentiality Integrity Availability), Access control matrix model. Certified Information Systems Security Professional (CISSP): 8 security domains, National Institute of Standards and Technology (NIST) Cybersecurity Framework: Risk Management Framework (RMF), |                             |                 |                                                 |

| Module II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Cryptographic Principles | 9 Hrs |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|-------|
| Classical Encryption Techniques & their cryptanalysis: Stream Ciphers, Substitution Techniques: Caesar, Mono alphabetic Ciphers, Playfair Cipher, Hill Cipher, Poly alphabetic Ciphers, Transposition Techniques, Block Ciphers, Data Encryption Standards (DES), 3DES, Advanced Encryption standard. Public key Cryptography & RSA, Mutual trust: Key Management & distribution, Diffie–Hellman key exchange, Elliptic curve cryptography.                                              |                          |       |
| Module III                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Hashing Techniques       | 9 Hrs |
| Hash Functions and Digital Signatures: cryptographic hash, Message Digest (MD5), Secure Hash Algorithm (SHA) SHA1 SHA-256, SHA-512, Message authentication code: message authentication requirements, functions, security of MAC – HMAC.                                                                                                                                                                                                                                                 |                          |       |
| Module IV                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Authentication           | 9 Hrs |
| Introduction: Introduction: objective, Measurements, Authentication methods: Password-based, two-factor, biometric, multi-factor authentication (MFA). Digital Signatures, Association of Digital signatures & Encryption. Digital Signature algorithms, digital signature standards, application of digital signature, authentication protocols.                                                                                                                                        |                          |       |
| <b>Text Books:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                          |       |
| <b>T1.</b> W. Stallings, <i>Cryptography and Network Security: Principles and Practice</i> , 7th ed. Hoboken, NJ, USA: Pearson, Jun. 2017. ISBN: 978-1-292-15858-7.<br><b>T2.</b> B. A. Forouzan and D. Mukhopadhyay, <i>Cryptography and Network Security</i> , 2nd ed. New Delhi, India: Tata McGraw-Hill, 2015. ISBN: 978-00-707-0208-0.<br><b>T3.</b> M. Bishop, <i>Computer Security: Art and Science</i> , 2nd ed. Boston, MA, USA: Pearson Education, 2018. ISBN: 978-0321712332. |                          |       |
| <b>Reference Books:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                          |       |
| <b>R1.</b> B. Menezes, <i>Network Security and Cryptography</i> . New Delhi, India: Cengage Learning India, 2014. ISBN: 8131513491.<br><b>R2.</b> A. Kahate, <i>Cryptography and Network Security</i> , 3rd ed. New Delhi, India: McGraw Hill Education, Jul. 2017. ISBN: 978-1259097607.<br><b>R3.</b> V. K. Pachghare, <i>Cryptography and Information Security</i> , 2nd ed. New Delhi, India: PHI Learning, Mar. 2015. ISBN: 978-81-203-5082-3.                                      |                          |       |
| <b>Relevant MOOCs Courses:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                          |       |
| 1. Cryptography and Network Security Prof. Sourav Mukhopadhyay, IIT Kharagpur<br><a href="https://onlinecourses.nptel.ac.in/noc20_cs21/preview">https://onlinecourses.nptel.ac.in/noc20_cs21/preview</a>                                                                                                                                                                                                                                                                                 |                          |       |
| <b>Relevant Topics for Self-study:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                          |       |
| <ul style="list-style-type: none"> <li>• Digital signatures in e-Governance (Adhaar / DigiLocker)</li> <li>• Password breach in social media platform</li> <li>• National Institute of Standards and Technology (NIST) Example for a given scenario to identify &amp; justify levels of compromise in CIA.</li> </ul>                                                                                                                                                                    |                          |       |
| <b>Other Resources/Links:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                          |       |
| 1. <a href="https://ocw.mit.edu/courses/">https://ocw.mit.edu/courses/</a>                                                                                                                                                                                                                                                                                                                                                                                                               |                          |       |

**Third Year B. Tech (T. Y B. Tech) AY (2026-27)****Computer Engineering (CE)****[2615PE31]: Program Elective - I Lab**

| Semester | Credits | Teaching Scheme | Examination Scheme                     |
|----------|---------|-----------------|----------------------------------------|
| 5        | 1       | P: 02 Hrs/week  | CIE(TW): 25 Marks<br>ESE(PR): 25 Marks |

**Data Warehousing and Mining Lab(DWML)****Course Objectives: The objective of this course is to provide students with**

- Preprocessing methods and transformation for effective data analysis and preparation. / Fundamental programming basics with preprocessing methods and transformation for effective data analysis and preparation.
- Basics of constructing multidimensional data models by building data cubes, and performing OLAP operations
- Knowledge of various algorithms in data mining to cultivate analytical and problem-solving skills.

**Course Outcomes: After completing this course, students will be able to****CO1: Apply** data preprocessing techniques for effective data analysis**CO2: Implement** OLAP operations for the given problem**CO3: Build** association rule mining to find patterns, rules in given data**CO4: Evaluate** the performance of classification and clustering techniques for a given problem.**List of Assignments**

| Expt. No | Problem Statement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | COs |
|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| 1        | Perform the following operations using Python on any open source dataset. Perform data Preprocessing: check for missing values, types of variables etc, perform data formatting and data Normalization: Summarize the types of variables by checking the data types (i.e., character, numeric, integer, factor, and logical) of the variables in the data set. If variables are not in the correct data type, apply proper type conversions. Turn categorical variables into quantitative variables in Python In addition to the codes and outputs, explain every operation that you do in the above steps and explain everything that you do to import/read/scrape the data set. | CO1 |
| 2        | Building cubes and OLAP analysis and construction of data mart. Take application of retail industry, construct data cube, apply OLAP operations and perform query. Create sales datamart and apply the ETL process.                                                                                                                                                                                                                                                                                                                                                                                                                                                               | CO2 |
| 3        | An online bookstore wants to analyze the purchase patterns of its customers. The management believes that certain books are often bought together, and by identifying these associations, they can recommend relevant books,                                                                                                                                                                                                                                                                                                                                                                                                                                                      | CO3 |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                         | improve cross-selling, and design effective marketing campaigns. Apply the Apriori algorithm to find frequent itemsets with a minimum support of 40%. From the frequent itemsets, generate association rules with minimum confidence of 60%.                                                                                                                                                                                                                                                                             |            |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                                       | A bank receives thousands of loan applications every month. To minimize financial risk, the bank wants to predict whether a loan application should be approved or rejected based on applicant details such as income, credit score, employment status, loan amount, loan term, and past default history. Build a classification model to predict loan approval (Approved = 1, Rejected = 0). Train at least two classification algorithms (e.g., Decision Tree, Naïve Bayes, SVM or KNN) and compare their performance. | C01<br>C04 |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>Mini project:</b> Based on the clustering algorithm.                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | C01<br>C04 |
| <b>File Systems and Rust Programming Lab(FSRPL)</b>                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |            |
| <b>Course Objectives: The objective of this course is to provide students with</b> <ul style="list-style-type: none"> <li>Basics of the file organization methods of OS</li> <li>Information of different Disk space organisation methods.</li> <li>A comprehensive understanding of the internal components and functioning of operating system file systems.</li> </ul>                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |            |
| <b>Course Outcomes: After completing this course, students will be able to</b><br><b>C01: Construct</b> a file system utility to manage the files.<br><b>C02: Differentiate</b> RUST system calls for storage management.<br><b>C03: Demonstrate</b> the ability to examine and interpret Linux file system structures and metadata using command-line tools.<br><b>C04: Develop</b> a small file handling component of the OS using RUST system calls. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |            |
| <b>Assignment List</b>                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |            |
| Expt. No.                                                                                                                                                                                                                                                                                                                                                                                                                                               | Problem Statement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | COs        |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Study and implement File System Utilities and Management: Creating, mounting, and unmounting file systems (e.g., mkfs, mount, umount), Checking and repairing file systems (fsck), Managing quotas and permissions.                                                                                                                                                                                                                                                                                                      | C01        |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Write a program that reads a large text file (100MB+), measures read time with and without caching (simulate this by reading line-by-line vs reading the entire file into memory), logs timing results and create a small report.                                                                                                                                                                                                                                                                                        | C02        |
| 3.                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Investigate File System Internals a) Use the command sudo dumpe2fs /dev/sdX (replace with actual device) to inspect the file system. b) Extract and explain: Superblock details, Block size, inode count, Mount count and interval c) Create files and observe changes using df or tune2fs.                                                                                                                                                                                                                              | C03        |
| 4.                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Implementation of File handling using RUST system calls.                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | C04        |
| 5.                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Mini Project a) Build a simple, minimal file system in Rust (e.g., in-memory or backed by a file) b) Demonstrate file creation, read/write, and metadata handling c) Testing and debugging techniques .                                                                                                                                                                                                                                                                                                                  | C04        |
| <b>Computer Graphics Lab(CGL)</b>                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |            |

**Course Objectives: The objective of this course is to provide students with**

- Basic 2-D and 3-D geometric transformations such as scaling, translation, and rotation
- Different Polygon filling algorithms
- Line clipping algorithm and fractal-based snowflake patterns
- Animation for ball movement and simple game such as maze or racing game

**Course Outcomes: After completing this course, students will be able to**

**CO1: Implement** basic 2-D and 3-D geometric transformations such as scaling, translation, and rotation to graphical objects like triangles and cubes using programming tools.

**CO2: Implement** scanline polygon filling algorithms to accurately fill convex/concave polygon shapes with user-defined colors.

**CO3: Develop** graphical programs using OpenGL that perform line clipping with the Cohen–Sutherland algorithm and generate fractal-based snowflake patterns through recursion and self-similarity.

**CO4: Integrate** OpenGL concepts for ball movements and simple game development such as maze or racing games.

**Assignment List**

| Expt.No. | Problem Statement                                                                                                                                                                                                                                                                                                                                                                                                                                          | COs |
|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| 1.       | Implement a program to draw a 2-D triangle and 3-D cube and enable users to perform the following transformations on it:<br>a) Scaling — resize the cube uniformly or non-uniformly<br>b) Translation — move the cube along the x, y, or z axis<br>c) Rotation — rotate the cube about any one of the axes (x, y, or z)                                                                                                                                    | CO1 |
| 2.       | Implement a program to draw a polygon of any shape and fill its interior with a desired color using the Scanline fill algorithm. The program should allow the user to select the fill color and demonstrate how the Scanline fill algorithm propagates to fill the polygon area correctly.                                                                                                                                                                 | CO2 |
| 3.       | Write a program using OpenGL that:<br>a) Allows users to input or define a set of lines by specifying their endpoints.<br>b) Defines a rectangular clipping window (viewport).<br>c) Implements the Cohen–Sutherland Line Clipping Algorithm to clip the input lines against the rectangular window.<br>d) Displays the original lines and the clipped lines within the viewport, clearly differentiating between them (e.g., different colors or styles). | CO3 |
| 4.       | Write a program that generates Snowflakes by applying fractal concepts, such as recursive branching and self-similarity.<br>a) Use recursion to draw Snowflake patterns (e.g., Koch snowflake)<br>b) Allow customization of recursion depth (level of fractal).                                                                                                                                                                                            | CO3 |
| 5.       | <b>Mini project (any 1):</b><br><b>1. Write a program using OpenGL that:</b><br>a) Move the ball up, down, left, and right using the arrow keys<br>b) Ensures smooth and continuous movement while the keys are pressed                                                                                                                                                                                                                                    | CO4 |

|                                                                                                                                                                                                                                                                                                                                                                                                 | <p>c) Prevents the ball from moving outside the window boundaries.</p> <p>2. Implement a simple maze or racing game using OpenGL. Include transformations for movement and collision detection</p>                                                                                                                                                                      |                     |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|
| <b>Client Side Technologies and Frameworks Lab (CSTFL)</b>                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                         |                     |
| <b>Course Objectives: The objective of this course is to provide students with</b> <ul style="list-style-type: none"> <li>• Exploration on HTML5 and CSS for web designing.</li> <li>• Knowledge of front-end validation and DOM manipulation.</li> <li>• Basic knowledge on developing React.js components.</li> <li>• Experience of rapid client-side development with frameworks.</li> </ul> |                                                                                                                                                                                                                                                                                                                                                                         |                     |
| <b>Course Outcomes: After completing this course, students will be able to</b><br><b>CO1: Develop</b> responsive and reusable web-pages.<br><b>CO2: Develop</b> programs for form validations and web-page manipulations.<br><b>CO3: Create</b> React.js application for dynamic content rendering.<br><b>CO4: Develop</b> client-side applications using advanced frameworks.                  |                                                                                                                                                                                                                                                                                                                                                                         |                     |
| <b>Assignment List</b>                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                         |                     |
| <b>Expt. No.</b>                                                                                                                                                                                                                                                                                                                                                                                | <b>Problem Statement</b>                                                                                                                                                                                                                                                                                                                                                | <b>CO's</b>         |
| <b>1</b>                                                                                                                                                                                                                                                                                                                                                                                        | Develop a multi-section responsive HTML5 webpage containing headings, paragraphs, images, tables, lists, forms, hyperlinks and semantic elements. Apply internal, external and inline CSS styles to enhance the page design. Also, implement clickable images and embedded media to display a product catalog with text.                                                | <b>CO1</b>          |
| <b>2</b>                                                                                                                                                                                                                                                                                                                                                                                        | Develop a JavaScript program to validate a registration form (Username, Email, Password, Confirm Password, age, etc.) with proper DOM manipulation to display error messages dynamically. Use AJAX with jQuery, to check whether the typed Username is available or not. Also, on clicking the submit button, the border color of discrepant fields must change to Red. | <b>CO2</b>          |
| <b>3</b>                                                                                                                                                                                                                                                                                                                                                                                        | Create a React.js application that displays a list of users using multiple functional components. Pass data between components using props and manage component states using <i>useState</i> .                                                                                                                                                                          | <b>CO3</b>          |
| <b>4</b>                                                                                                                                                                                                                                                                                                                                                                                        | Develop a Blog platform using Next.js that demonstrates dynamic routing, reusable UI components, and data rendering with props. The application should allow users to browse a list of blog posts and view individual post's details on a separate dynamically generated page. Use static data or a simple JSON file for product information.                           | <b>CO4</b>          |
| <b>5</b>                                                                                                                                                                                                                                                                                                                                                                                        | Mini-Project using any web tech-stack.                                                                                                                                                                                                                                                                                                                                  | <b>CO1-<br/>CO4</b> |
| <b>Cryptography Lab (CGRL)</b>                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                         |                     |
| <b>Course Objectives: The objective of this course is to provide students with</b> <ul style="list-style-type: none"> <li>• Common security threats and vulnerabilities in networks and systems</li> <li>• Fundamentals of cryptographic principles such as key exchange protocols, symmetric and</li> </ul>                                                                                    |                                                                                                                                                                                                                                                                                                                                                                         |                     |

| asymmetric encryption, and cryptanalysis techniques <ul style="list-style-type: none"> <li>• Develop Practical Cryptographic Skills</li> <li>• Design secure communication system</li> </ul>                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |      |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| <b>Course Outcomes: After completing this course, students will be able to</b><br><b>C01: Demonstrate &amp; evaluate</b> security limitations of unauthenticated key exchange mechanism<br><b>C02: Compute</b> the multiplicative inverse of integer under modular arithmetic<br><b>C03: Evaluate</b> vulnerability of substitution technique & compare complexity of breaking its cipher<br><b>C04: Demonstrate</b> secure data transmission using symmetric encryption<br><b>C05: Propose</b> mitigation strategies & secure authentication mechanism |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |      |
| <b>Assignment List</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |      |
| Expt. No                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Problem Statement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | CO's |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Implement the Diffie–Hellman Key Exchange mechanism using HTML & JavaScript. Consider the end user as one of the parties (Alice) & the JavaScript application as other party (bob). Also demonstrate MITM (man in the middle attack) on it.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | C01  |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Implement Euclid's algorithm to find GCD of two integers. Further implement extended Euclidean algorithm to find multiplicative inverse of the given integer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | C02  |
| 3.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Write a program that can perform a letter frequency attack on an additive cipher without human intervention. Your software should produce possible plaintexts in rough order of likelihood. It would be good if your user interface allowed the user to specify 'give me the top 10 possible plaintexts'.                                                                                                                                                                                                                                                                                                                                                                                                                         | C03  |
| 4.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Implement and compare the performance of two cryptographic algorithms (AES vs. DES / RSA vs. ECC) in terms of key length, computational efficiency, and security strength. Submit code implementation and analysis report. OR Write a program to apply Advanced Encryption Standard (AES) Algorithm for a practical application like URL Encryption.                                                                                                                                                                                                                                                                                                                                                                              | C04  |
| 5.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Mini-Project:<br>1) With the rapid increase in online communication, phishing attacks have become a major cybersecurity threat, especially among students and employees. Many users fail to identify fraudulent emails and malicious links, leading to data breaches and financial loss. This project aims to study a real-world phishing attack scenario and develop a simple phishing detection and awareness system to reduce the risk of such attacks.<br>2) Weak and reused passwords are one of the primary reasons for unauthorized access to systems. This case-based study analyzes a password-related security breach and proposes a secure password management and authentication mechanism to enhance system security | C05  |



| Third Year B. Tech (T. Y B. Tech) AY (2026-27)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                   |                 |                                                 |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|-----------------|-------------------------------------------------|
| Computer Engineering (CE)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                   |                 |                                                 |
| [2605MD11]: Data Analytics for Smart and Sustainable Systems (DASSS)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                   |                 |                                                 |
| Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Credits                           | Teaching Scheme | Examination Scheme                              |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 2                                 | L: 02 Hrs./week | CIE: 20 Marks<br>ISE: 20 Marks<br>ESE: 60 Marks |
| Prerequisite: Students should have prior knowledge of <ul style="list-style-type: none"><li>IoT, Analytical Thinking</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                   |                 |                                                 |
| Course Objectives: The objective of this course is to provide students with <ul style="list-style-type: none"><li>Foundational concepts of data analytics as applied to smart and sustainable systems.</li><li>Visualizations techniques to analyze the data and patterns in smart and sustainable applications.</li><li>Applications of data analytics techniques to real-world sustainability challenges, utilizing tools and machine learning algorithms to derive actionable insights.</li><li>Knowledge for analyzing data-driven solutions to enhance the efficiency of smart systems in multidisciplinary domains to address complex sustainability issues.</li></ul> |                                   |                 |                                                 |
| Course Outcomes: After completing this course, students will be able to:<br>C01: Illustrate the data modelling of smart and sustainable systems.<br>C02: Analyze IoT Data for predictive insights and visualisation.<br>C03: Apply data analytics techniques and tools for decision making in smart and sustainable systems.<br>C04: Design solutions to address real-world challenges in IoT analytics.                                                                                                                                                                                                                                                                     |                                   |                 |                                                 |
| COURSE CONTENTS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                   |                 |                                                 |
| Module I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Introduction to Data Analytics    |                 | 8 Hrs                                           |
| Data modeling of smart and sustainable systems: Definition, need, types and nature of data in smart systems, classification and scales of measurements. Statistical methods for data analysis, Overview of data analytics life cycle, Datasets in sustainable systems - case studies, Real-time data streaming, Preprocessing techniques - Handling missing values, Detecting and addressing outliers, Ensuring data consistency, Feature engineering, Challenges in data handling.                                                                                                                                                                                          |                                   |                 |                                                 |
| Module II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Data Analytics for Sustainability |                 | 6 Hrs                                           |
| Exploratory Data Analysis (EDA), correlations and Regression (Pearson, Spearson) Data Visualization of sustainable insights. Predictive Modeling- Regression for Predicting continuous sustainable outcomes (e.g., emissions), Classification, Model evaluation and selection, Anomaly Detection. Case studies - smart city.                                                                                                                                                                                                                                                                                                                                                 |                                   |                 |                                                 |
| Module III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Emerging Technologies and Tools   |                 | 6 Hrs                                           |
| Tools and platforms for IoT data analytics (e.g., Apache Kafka, Spark Streaming), Integrating IoT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                   |                 |                                                 |

|                                                                                                                                                                                                                                                                                                                                                                                          |                     |              |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|--------------|
| data with smart systems involving environmental data such as Geospatial Information Systems (GIS). Location-based services using IoT (e.g., smart traffic control, smart parking) anomaly detection in IoT sensor streams for fault detection, Predictive maintenance and energy consumption forecasting.                                                                                |                     |              |
| <b>Module IV</b>                                                                                                                                                                                                                                                                                                                                                                         | <b>Case Studies</b> | <b>6 Hrs</b> |
| Building dashboard applications for smart sustainable systems which involves data collection, analytics, and decision-making:                                                                                                                                                                                                                                                            |                     |              |
| <ol style="list-style-type: none"> <li>1. IoT-driven smart city projects: waste management, water conservation</li> <li>2. ESG reporting of various industries</li> <li>3. Gender equality, Economic growth</li> </ol>                                                                                                                                                                   |                     |              |
| <b>Text Books:</b>                                                                                                                                                                                                                                                                                                                                                                       |                     |              |
| <b>T1.</b> J. Dunn and P. Balaprakash, <i>Data Science Applied to Sustainability Analysis</i> . Amsterdam, Netherlands: Elsevier, 2021. ISBN: 9780128179765, 9780128179772.<br><b>T2.</b> J. M. Gómez and Y. Yesufu, <i>Sustainable Development Through Data Analytics and Innovation</i> . Cham, Switzerland: Springer International Publishing, 2022. ISBN: 3031125274, 9783031125270. |                     |              |
| <b>Reference Books:</b>                                                                                                                                                                                                                                                                                                                                                                  |                     |              |
| <b>R1.</b> H. Dulay and R. M. Debusmann, <i>Streaming Databases</i> , 1st ed. Sebastopol, CA, USA: O'Reilly Media, 2024. ISBN: 9789355427250.<br><b>R2.</b> M. Chinnici, F. Pop, and C. Negru, <i>Data Science and Big Data Analytics in Smart Environments</i> , 1st ed. Boca Raton, FL, USA: CRC Press, 2022. ISBN: 9780367814397.                                                     |                     |              |
| <b>Relevant MOOCs Courses:</b>                                                                                                                                                                                                                                                                                                                                                           |                     |              |
| <ol style="list-style-type: none"> <li>1. Data Analytics by Prof. Chandan Chakraborty, National Institute of Technical Teachers Training and Research, Kolkata, link: <a href="https://onlinecourses.swayam2.ac.in/e-learning/preview/ntr26_ed08">https://onlinecourses.swayam2.ac.in/e-learning/preview/ntr26_ed08</a></li> </ol>                                                       |                     |              |
| <b>Relevant Topics for Self-study:</b>                                                                                                                                                                                                                                                                                                                                                   |                     |              |
| <ol style="list-style-type: none"> <li>1. ESG and ESG reports</li> <li>2. Tools to build dashboards to track carbon footprint</li> </ol>                                                                                                                                                                                                                                                 |                     |              |
| <b>Other Resources/Links:</b>                                                                                                                                                                                                                                                                                                                                                            |                     |              |
| <ol style="list-style-type: none"> <li>1. <a href="https://wires.onlinelibrary.wiley.com/doi/epdf/10.1002/widm.1319">https://wires.onlinelibrary.wiley.com/doi/epdf/10.1002/widm.1319</a></li> </ol>                                                                                                                                                                                     |                     |              |



| Third Year B. Tech (T. Y B. Tech) AY (2026-27)<br>Computer Engineering (CE)<br>[2605MD31]: Data Analytics for Smart and Sustainable Systems Laboratory<br>(DASSSL)                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                 |                 |                    |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|--------------------|
| Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Credits                                                                                                                                                                                                                                                                                         | Teaching Scheme | Examination Scheme |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 1                                                                                                                                                                                                                                                                                               | P: 02 Hrs./week | CIE(TW): 25 Marks  |
| <b>Prerequisite:</b> Students should have prior knowledge of <ul style="list-style-type: none"><li>Foundation of Smart and Sustainable Systems</li></ul>                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                 |                 |                    |
| <b>Course Objectives:</b> The objective of this course is to provide students with <ul style="list-style-type: none"><li>The visualizations techniques to analyze the data and patterns in smart and sustainable applications.</li><li>Applications of data analytics techniques to real-world sustainability challenges, utilizing tools and machine learning algorithms to derive actionable insights.</li><li>Knowledge to enhance the efficiency of smart systems in multidisciplinary domains to address complex sustainability issues.</li></ul> |                                                                                                                                                                                                                                                                                                 |                 |                    |
| <b>Course Outcomes:</b> After completing this course, students will be able to<br><b>CO1: Analyze</b> IoT Data for predictive insights and visualisation.<br><b>CO2: Apply</b> data analytics techniques and tools for decision making in smart and sustainable systems.<br><b>CO3: Design</b> solutions to address real-world challenges in IoT analytics.                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                 |                 |                    |
| List of Assignments                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                 |                 |                    |
| Sr.No.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Problem Statements                                                                                                                                                                                                                                                                              | COs             |                    |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Visualize and analyze water usage data for a locality or smart irrigation system.                                                                                                                                                                                                               | CO1             |                    |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Develop a model to predict crop yield based on soil and weather data.                                                                                                                                                                                                                           | CO2             |                    |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Classify energy usage patterns in smart homes to optimize consumption                                                                                                                                                                                                                           | CO2             |                    |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Apply linear regression to predict future energy/water consumption.                                                                                                                                                                                                                             | CO2             |                    |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>Mini-Project:</b><br>Build a real-time energy utilization monitoring dashboard using IoT and analytics. <b>OR</b><br>Build a real-time air quality monitoring dashboard using IoT and analytics. <b>OR</b><br>Create a water conservation recommendation engine based on user behavior data. | CO3             |                    |



| Third Year B. Tech (T. Y B. Tech) AY (2026-27)                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                          |                 |                    |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|--------------------|
| Computer Engineering (CE)                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                          |                 |                    |
| [2605AE31]: Leadership and Management Skills                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                          |                 |                    |
| Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Credits                                                                                                                                                                  | Teaching Scheme | Examination Scheme |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 1                                                                                                                                                                        | P: 02 Hrs/week  | CIE (TW): 25 Marks |
| Prerequisite: Students should have prior knowledge of                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                          |                 |                    |
| <ul style="list-style-type: none"><li>Course on Soft Skills (SS), and Professional Skills 1, Professional Skills 2</li></ul>                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                          |                 |                    |
| Course Objectives: The objective of this course is to provide students with                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                          |                 |                    |
| <ul style="list-style-type: none"><li>Develop essential skills to influence and motivate others.</li><li>Inculcate emotional and social intelligence and integrative thinking for effective leadership.</li><li>Create and maintain an effective and motivated team to work for the society.</li><li>Nurture a creative and entrepreneurial mindset.</li><li>Help understand the personal values and apply ethical principles in professional and Social contexts.</li></ul> |                                                                                                                                                                          |                 |                    |
| Course Outcomes: After completing this course, students will be able to                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                          |                 |                    |
| CO1: Examine various leadership models and understand and/or assess their skills, strengths and abilities that affect their personal leadership style and can create a leadership vision.                                                                                                                                                                                                                                                                                    |                                                                                                                                                                          |                 |                    |
| CO2: Analyze and demonstrate a set of practical skills such as time management, self-management, handling conflicts, and team leadership.                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                          |                 |                    |
| CO3: Understand the basics of entrepreneurship and develop business plans.                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                          |                 |                    |
| CO4: Apply the design thinking approach for leadership.                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                          |                 |                    |
| Assignment List                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                          |                 |                    |
| Sr. No.                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Problem Statement                                                                                                                                                        |                 | COs                |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Leadership Skills, Understanding Leadership and its Importance, Traits and Models of Leadership, Basic Leadership Skills                                                 |                 | CO1                |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Managerial Skills - Basic Managerial Skills                                                                                                                              |                 | CO2                |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Managerial Skills - Self-management Skills                                                                                                                               |                 | CO2                |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Entrepreneurship Skills Meaning of entrepreneurship, Classification and types of entrepreneurships, Traits and competencies of entrepreneur                              |                 | CO3                |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Creating Business Plan Problem identification and idea generation, Idea validation, Pitch making                                                                         |                 | CO3                |
| 6                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Innovative Leadership, Concept of emotional and social intelligence, Synthesis of human and artificial intelligence, why does culture matter for today's global leaders? |                 | CO4                |
| 7                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Design Thinking, What is design thinking?<br>- Key elements of design thinking:<br>- How to transform challenges into opportunities?                                     |                 | CO4                |
| Text Books:                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                          |                 |                    |

|                                                                                                                                                                                                     |
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| <b>T1.</b> C. S. G. Krishnamacharyulu and L. Ramakrishnan, <i>Leadership and Management Skills</i> . Mumbai, India: Himalaya Publishing House, 2022. ISBN: 978-93-5596-074-0.                       |
| <b>Reference Books:</b>                                                                                                                                                                             |
| <b>R1.</b> J. C. Collins, <i>Good to Great: Why Some Companies Make the Leap... and Others Don't</i> . New York, NY, USA: HarperCollins Publishers LLC, Oct. 2001. ISBN: 9780066620992, 0066620996. |
| <b>R2.</b> S. R. Covey, <i>The Seven Habits of Highly Effective People</i> , 12th ed. New York, NY, USA: Simon & Schuster, Jan. 2019. ISBN: 1471131823.                                             |
| <b>Relevant Topics for Self-study:</b>                                                                                                                                                              |
| -                                                                                                                                                                                                   |
| <b>Other Resources:</b>                                                                                                                                                                             |
| 1. NPTEL Course on Design Thinking - A Primer by By Prof. Ashwin Mahalingam, Prof. Bala Ramadurai , IIT Madras                                                                                      |



|                                                                                                                                        |                    |                                                  |
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| <b>Third Year B. Tech (T. Y B. Tech) AY (2026-27)</b><br><b>Computer Engineering (CE)</b><br><b>[26050E51]: NPTEL / SWAYAM / MOOCs</b> |                    |                                                  |
| <b>Teaching Scheme:</b><br><b>Online 2 Hrs/ Week</b>                                                                                   | <b>Credits: 02</b> | <b>Evaluation Scheme</b><br><b>ESE: 50 Marks</b> |
| <b><u>Refer Annexure II</u></b>                                                                                                        |                    |                                                  |

PICT CE TY 2026

**Third Year B-Tech  
(T. Y. B. Tech)  
Semester-6**



| Third Year B. Tech (T. Y B. Tech) AY (2026-27)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                       |                 |                                                 |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|-----------------|-------------------------------------------------|
| Computer Engineering (CE)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                       |                 |                                                 |
| [2616PC11] : Cloud and Distributed Computing (CDC)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                       |                 |                                                 |
| Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Credits                               | Teaching Scheme | Examination Scheme                              |
| 6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 3                                     | L: 03 Hrs./week | CIE: 20 Marks<br>ISE: 20 Marks<br>ESE: 60 Marks |
| Prerequisite: Students should have prior knowledge of                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                       |                 |                                                 |
| <ul style="list-style-type: none"><li>• Computer Networks, Operating Systems, Computer Architecture</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                       |                 |                                                 |
| Course Objectives: The objective of this course is to provide students with                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                       |                 |                                                 |
| <ul style="list-style-type: none"><li>• Fundamental concepts of distributed computing.</li><li>• Distributed programming models in real-world scenarios.</li><li>• Different cloud platforms (e.g., AWS, Azure, GCP) for different applications.</li><li>• Cloud DevOps tools for automating application development and deployment.</li></ul>                                                                                                                                                                                                                                                                                                                                                               |                                       |                 |                                                 |
| Course Outcomes:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                       |                 |                                                 |
| After successful completion of this course, the student will be able to:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                       |                 |                                                 |
| CO1: Illustrate the fundamental concepts and architecture of distributed computing systems.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                       |                 |                                                 |
| CO2: Compare different distributed programming models for solving computing problems.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                       |                 |                                                 |
| CO3: Analyze services of various cloud platforms (e.g., AWS, Azure, GCP) for a given application.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                       |                 |                                                 |
| CO4: Differentiate cloud DevOps tools for automating application development.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                       |                 |                                                 |
| COURSE CONTENTS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                       |                 |                                                 |
| Module I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Introduction to Distributed Computing |                 | 12 Hrs                                          |
| Overview of Concurrent, Parallel and Distributed Computing. Parallel programming models, Characteristics, Design goals, Applications, Issues in Distributed Computing. Types of Distributed Systems. System architecture, Types of Communication, Remote Procedural Call, Message Oriented Communication, Multicast Communication. Clock Synchronization, Logical Clocks, Mutual Exclusion, Election Algorithms, Gossip-Based Contribution, Introduction to MPI, Process Management, Point-to-Point Communication, Collective Communication: Broadcast, scatter, and gather, Reduction operations All-to-all communication, Derived Data Types, Process Topologies, File I/O in MPI, Practical Applications. |                                       |                 |                                                 |
| Module II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Distributed Computing using CUDA      |                 | 9 Hrs                                           |

Introduction to CUDA and GPU Architecture: Overview of parallel computing paradigms, CUDA programming model and architecture, GPU vs CPU: Differences and use cases  
 CUDA Programming Basics: CUDA development environment setup Kernel functions and execution configuration  
 Memory hierarchy in CUDA: global, shared, constant, and local memory  
 Parallel Algorithm Design Using CUDA: Data parallelism and task parallelism concepts  
 Thread hierarchy: grids, blocks, and threads  
 Synchronization and communication between threads  
 Optimization Techniques: Memory coalescing and bank conflicts, Shared memory usage for performance improvement  
 Minimizing thread divergence  
 Distributed Computing Concepts in CUDA: Multi-GPU programming basics  
 CUDA streams and asynchronous execution, Handling data distribution and communication across GPUs  
 Applications and Case Studies: Implementing common parallel algorithms (e.g., matrix multiplication, reduction)  
 Real-world applications of CUDA in scientific computing, image processing, and machine learning.

### Module III

### Cloud Computing and AWS Essential

9 Hrs

Origins of Cloud computing – Cloud components - Essential characteristics, Cloud model: SAAS, PAAS & IAAS. Virtualization, Introduction to Amazon Web Services, EC2: Compute services, Networking, infrastructure and reliability, Storage and database services, Amazon Elastic Block Store (Amazon EBS), Amazon Simple Storage Service (Amazon S3), Amazon Elastic File System (Amazon EFS), Amazon Relational Database Service (Amazon RDS), Amazon virtual private cloud (VPC), Identity and Access Management (IAM) and Security on AWS.

### Module IV

### Azure, GCP Essentials and recent trends

9 Hrs

Azure core concepts, Azure services, Describe core solutions and management tools on Azure, Describe general security and network security features, Azure cost management and service level agreements. Google Cloud Fundamentals: Core Infrastructure-Google App Engine, Google Compute Engine, Google Kubernetes Engine, Google Cloud Storage, Google Cloud SQL, and BigQuery. Google Cloud Resource Manager hierarchy, Google Cloud Identity and Access Management , Design and Process Serverless computing, Microservices, Comparing the services and efficiency of AWS, Azure and GCP with respect to resource management. Devops Tools: containers and Dockers, Kubernetes, Jenkins, Terraform/Pulumi, Prometheus, Grafana.

### Text Books:

- T1.** A. S. Tanenbaum and M. van Steen, *Distributed Systems: Principles and Paradigms*, 3rd ed. Upper Saddle River, NJ, USA: Pearson Education, 2007. ISBN: 978-1543057386.
- T2.** S. Cook, *CUDA Programming: A Developer's Guide to Parallel Computing with GPUs*, 1st ed. Burlington, MA, USA: Morgan Kaufmann, 2013. ISBN: 978-0124159334.
- T3.** G. Coulouris, J. Dollimore, and T. Kindberg, *Distributed Systems: Concepts and Design*, 5th ed. Noida, India: Pearson Education, Mar. 2017. ISBN: 978-9332575226.

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| <b>Reference Books:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <p><b>R1.</b> A. Grama, A. Gupta, G. Karypis, and V. Kumar, <i>Introduction to Parallel Computing</i>, 2nd ed. Boston, MA, USA: Pearson Education, 2003. ISBN: 9780201648652.</p> <p><b>R2.</b> B. Wilkinson and M. Allen, <i>Parallel Programming: Techniques and Applications Using Networked Workstations and Parallel Computers</i>, 2nd ed. Upper Saddle River, NJ, USA: Pearson, 2005. ISBN: 9780131405639, 0-13-140563-2.</p> <p><b>R3.</b> A. D. Kshemkalyani and M. Singhal, <i>Distributed Computing: Principles, Algorithms and Systems</i>. Cambridge, U.K.: Cambridge University Press, 2011. ISBN: 9780521189842.</p> <p><b>R4.</b> R. Buyya, C. Vecchiola, and S. Thamrai, <i>Mastering Cloud Computing</i>, 1st ed. New Delhi, India: McGraw-Hill Education, 2017. ISBN: 9781259029950; 9780124114548.</p> <p><b>R5.</b> E. Pace <i>et al.</i>, <i>Developing Applications for the Cloud on the Microsoft Windows Azure Platform</i>, 1st ed. Redmond, WA, USA: Microsoft Press, 2010. ISBN: 9780735656062.</p> <p><b>R6.</b> B. A. Sosinsky, <i>Cloud Computing Bible</i>, 1st ed. Hoboken, NJ, USA: Wiley Publishing, 2010. ISBN: 9780470903568.</p> |
| <b>Relevant MOOCs Courses:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <ol style="list-style-type: none"> <li>1. Introduction of Parallel Computing, IIT Delhi, Dr. Subodh Kumar, <a href="https://nptel.ac.in/courses/106102114">https://nptel.ac.in/courses/106102114</a></li> <li>2. Introduction to Cloud Computing, IBM, Rav Ahuja, <a href="https://www.coursera.org/learn/introduction-to-cloud">https://www.coursera.org/learn/introduction-to-cloud</a></li> <li>3. Google Cloud Devops Fundamentals, Coursera, Board Infinity, <a href="https://www.coursera.org/learn/google-cloud-devops-fundamentals">https://www.coursera.org/learn/google-cloud-devops-fundamentals</a></li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Relevant Topics for Self-study:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <ol style="list-style-type: none"> <li>1. MapReduce Programming</li> <li>2. GPU vs CPU architecture comparison</li> <li>3. Container-based distributed execution using Docker &amp; Kubernetes</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Other Resources/Links:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <ol style="list-style-type: none"> <li>1. <a href="https://openmp.org">https://openmp.org</a></li> <li>2. <a href="https://mpi4py.readthedocs.io">https://mpi4py.readthedocs.io</a></li> <li>3. <a href="https://spark.apache.org">https://spark.apache.org</a></li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |



| Third Year B. Tech (T. Y B. Tech) AY (2026-27)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                       |                 |                                                 |
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| Computer Engineering (CE)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                       |                 |                                                 |
| [2616PC12]: Design and Analysis of Algorithms (DAA)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                       |                 |                                                 |
| Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Credits                                               | Teaching Scheme | Examination Scheme                              |
| 6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 2                                                     | L: 02 Hrs/week  | CIE: 20 Marks<br>ISE: 20 Marks<br>ESE: 60 Marks |
| Prerequisite: Students should have prior knowledge of                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                       |                 |                                                 |
| <ul style="list-style-type: none"><li>Discrete Mathematics, Data structures</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                       |                 |                                                 |
| Course Objectives: The objective of this course is to provide students with                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                       |                 |                                                 |
| <ul style="list-style-type: none"><li>Basic types of problems and fundamentals of algorithm analysis in terms of time and space.</li><li>Basics of algorithmic strategies to solve given computing problems.</li><li>Concept of string, graph and randomized algorithms.</li></ul>                                                                                                                                                                                                                                                                                                                                                          |                                                       |                 |                                                 |
| Course Outcomes: After completing this course, students will be able to:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                       |                 |                                                 |
| CO1: Analyze the algorithms based on time and space complexity for the P, NP, NP complete and NP hard problems.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                       |                 |                                                 |
| CO2: Apply dynamic programming strategy for solving the optimization problems.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                       |                 |                                                 |
| CO3: Use backtracking, branch & bound strategies for solving the combinatorial and constraint satisfaction problems.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                       |                 |                                                 |
| CO4: Solve string matching, shortest path and quick sort problems using string, graph and randomize algorithms.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                       |                 |                                                 |
| COURSE CONTENTS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                       |                 |                                                 |
| Module I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Fundamentals of Algorithms and Basic Design Paradigms |                 | 8 Hrs.                                          |
| Introduction and Analysis of Algorithms: Types of Problems: P, NP, NP complete and NP hard, Algorithmic problem solving, Measuring performance: time and space complexity, Best, worst, and average case analysis, Amortized analysis (Aggregate, Accounting, Potential Methods).Divide and Conquer: Recurrence relations: Concept and recurrence solving (Master Theorem), Binary Search, Concurrent Merge Sort, Matrix Multiplication (Strassen's algorithm).Greedy Algorithms: Greedy strategy and correctness, Huffman Coding, Fractional Knapsack Case Study: Derive the relation between best, average and worst case for Quick Sort. |                                                       |                 |                                                 |
| Module II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Dynamic Programming Techniques                        |                 | 6 Hrs.                                          |
| Dynamic Programming – Tabulation vs. Memorization, Optimal Substructure and Overlapping Subproblems, 0/1 Knapsack, Matrix Chain Multiplication, Longest Common Subsequence, Longest                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                       |                 |                                                 |

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| Increasing Subsequence, Edit Distance, DP with Bitmasking. Case Study: Use of Dynamic Programming for OBST                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                          |               |
| <b>Module III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>Backtracking and Branch and Bound</b> | <b>6 Hrs.</b> |
| Backtracking: Concept and Need of backtracking, N-Queens, Subset Sum, Hamiltonian Path. Branch and Bound: Difference from Backtracking, State Space Tree, 0/1 Knapsack (with bounding functions), TSP (Traveling Salesman Problem). Case Study: Application of branch and bound for 15 puzzle problem                                                                                                                                                                                                                                                                                                                                                                                            |                                          |               |
| <b>Module IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>Specialized Algorithms</b>            | <b>6 Hrs.</b> |
| String Algorithms: Pattern Matching: Naive, Knuth-Morris-Pratt (KMP) , Rabin-Karp, Z-algorithm, Trie and Suffix Tree/Array (conceptual overview). Graph Algorithms – SCCs (Kosaraju's Algorithm), Dijkstra, Bellman-Ford, Floyd-Warshall, Union-Find and Applications. Randomized Algorithms: Las Vegas vs. Monte Carlo, Randomized QuickSort, Hashing (Universal Hashing). Case Study: Application of String Matching algorithms in Text Processing.                                                                                                                                                                                                                                            |                                          |               |
| <b>Text Books:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                          |               |
| <b>T1.</b> P. H. Dave and H. B. Dave, <i>Design and Analysis of Algorithms</i> . New Delhi, India: Pearson Education, 2014. ISBN: 81-7758-595-9, 9788131799437.<br><b>T2.</b> G. Brassard and P. Bratley, <i>Fundamentals of Algorithmics</i> . New Delhi, India: PHI Learning, 2003. ISBN: 978-81-203-1131-2.<br><b>T3.</b> T. H. Cormen, C. E. Leiserson, R. L. Rivest, and C. Stein, <i>Introduction to Algorithms</i> , 3rd ed. Cambridge, MA, USA: MIT Press, 2009. ISBN: 978-0262033848, 9788120340077.                                                                                                                                                                                    |                                          |               |
| <b>Reference Books:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                          |               |
| <b>R1.</b> M. T. Goodrich and R. Tamassia, <i>Algorithm Design: Foundations, Analysis, and Internet Examples</i> , 1st ed. Hoboken, NJ, USA: Wiley, Jan. 2006. ISBN: 978-81-265-0986-7.<br><b>R2.</b> E. Horowitz and S. Sahni, <i>Fundamentals of Computer Algorithms</i> , 2nd ed. Hyderabad, India: Universities Press, 2010. ISBN: 978-81-7371-6126.<br><b>R3.</b> R. Motwani and P. Raghavan, <i>Randomized Algorithms</i> , 1st ed. Cambridge, U.K.: Cambridge University Press, Jan. 2004. ISBN: 978-0-521-61390-3.<br><b>R4.</b> D. Gusfield, <i>Algorithms on Strings, Trees, and Sequences</i> , 1st ed. Cambridge, U.K.: Cambridge University Press, Jun. 1997. ISBN: 978-0521585194. |                                          |               |
| <b>Relevant MOOCs Courses:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                          |               |
| 1. Design and Analysis of Algorithms -- IIT Madras (NPTEL)<br><a href="https://nptel.ac.in/courses/106106131">https://nptel.ac.in/courses/106106131</a><br>2. Design and Analysis of Algorithms – IIT Kharagpur (NPTEL)<br><a href="https://nptel.ac.in/courses/106105157">https://nptel.ac.in/courses/106105157</a><br>3. Design and Analysis of Algorithms – University of California, San Diego (Coursera)-<br><a href="https://www.coursera.org/specializations/data-structures-algorithms">https://www.coursera.org/specializations/data-structures-algorithms</a>                                                                                                                          |                                          |               |
| <b>Relevant Topics for Self-study:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                          |               |

Divide & Conquer: Closest Pair of Points. Greedy Method: Job Sequencing with deadlines, Approximation Algorithms: Set Cover, Greedy and Local Search Strategies.

**Other Resources/Links:**

1. [https://www.tutorialspoint.com/design\\_and\\_analysis\\_of\\_algorithms/index.htm](https://www.tutorialspoint.com/design_and_analysis_of_algorithms/index.htm)
2. <https://visualgo.net/en>
3. [https://www.mygreatlearning.com/academy/learn-for-free/courses/algorithms?utm\\_source=chatgpt.com](https://www.mygreatlearning.com/academy/learn-for-free/courses/algorithms?utm_source=chatgpt.com)
4. <https://www.classcentral.com/course/youtube-design-and-analysis-of-algorithms-47403>



| <b>Third Year B. Tech (T. Y B. Tech) AY (2026-27)</b><br><b>Computer Engineering (CE)</b><br><b>[2616PC31]: Software Lab (SL)</b>                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                        |                                                      |
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| <b>Semester</b>                                                                                                                                                                                                                                                                                                                                                                                              | <b>Credits</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>Teaching Scheme</b> | <b>Examination Scheme</b>                            |
| <b>6</b>                                                                                                                                                                                                                                                                                                                                                                                                     | <b>1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>P: 02 Hrs/week</b>  | <b>CIE(TW): 25 Marks</b><br><b>ESE(PR): 25 Marks</b> |
| <b>Prerequisite: Students should have prior knowledge of</b> <ul style="list-style-type: none"><li>• Data Structures, Basic Programming, Computer Networks, Operating Systems, Computer Architecture</li></ul>                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                        |                                                      |
| <b>Course Objectives: The objective of this course is to provide students with</b> <ul style="list-style-type: none"><li>• Understanding of parallel programming library and API</li><li>• Exploring distributed frameworks like Spark and Hadoop</li><li>• Learn problem solving using different algorithmic strategies</li><li>• Understanding techniques for improving efficiency of algorithms</li></ul> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                        |                                                      |
| <b>Course Outcomes: After completing this course, students will be able to</b><br><b>CO1: Implement</b> message passing interface in distributed environment<br><b>CO2: Deploy</b> applications on Cloud platforms<br><b>CO3: Implement</b> different algorithmic strategies and analyze time and space complexity.<br><b>CO4: Develop</b> efficient solutions for real life problems                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                        |                                                      |
| <b>List of Assignments</b>                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                        |                                                      |
| <b>Expt. No.</b>                                                                                                                                                                                                                                                                                                                                                                                             | <b>Problem Statement</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                        | <b>CO's</b>                                          |
| <b>1</b>                                                                                                                                                                                                                                                                                                                                                                                                     | <b>Design and implement a distributed application</b> to perform matrix multiplication and reduction operations on large matrices using MPI for inter-process communication and CUDA for GPU-based parallel computation.                                                                                                                                                                                                                                                                                                                 |                        | <b>CO1</b>                                           |
| <b>2</b>                                                                                                                                                                                                                                                                                                                                                                                                     | <b>Develop a serverless cloud-based application</b> using AWS services and implement an equivalent solution using Azure or Google Cloud Platform (GCP) to understand virtualization, serverless computing, security, and cost efficiency in modern cloud platforms.                                                                                                                                                                                                                                                                      |                        | <b>CO2</b>                                           |
| <b>3</b>                                                                                                                                                                                                                                                                                                                                                                                                     | Write a program in C++/Java/Python to solve the given problem. Given a set of $n$ points in a 2D plane, find the pair with the minimum Euclidean distance. A naive approach is $O(n^2)$ . Choose a suitable algorithmic strategy to solve it in $O(n \log n)$ .<br><b>OR</b><br>The travelling salesman problem using graph. The solution that is needed to be found for this problem is the shortest possible route in which the salesman visits all the cities and returns to the origin city. Solve using branch and bound technique. |                        | <b>CO3</b>                                           |

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| 4 | <p>Given two strings s1 and s2 and below operations that can be performed on s1. The task is to find the minimum number of edits (operations) to convert 's1' into 's2'.</p> <ul style="list-style-type: none"> <li>• Insert: Insert any character before or after any index of s1</li> <li>• Remove: Remove a character of s1</li> <li>• Replace: Replace a character at any index of s1 with some other character</li> </ul> <p style="text-align: center;"><b>OR</b></p> <p>Given a string s, find the length of the longest proper prefix which is also a suffix. A proper prefix is a prefix that doesn't include the whole string. For example, prefixes of "abc" are "", "a", "ab" and "abc" but proper prefixes are "", "a" and "ab" only.</p> | <b>C03</b> |
| 5 | Implement a miniproject using the algorithmic design techniques for a real life application.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>C04</b> |



| Third Year B. Tech (T. Y B. Tech) AY (2026-27)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                        |                 |                                                 |
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| Computer Engineering (CE)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                        |                 |                                                 |
| [2606MD11]: Security for Smart and Sustainable Systems (SESS)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                        |                 |                                                 |
| Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Credits                                                | Teaching Scheme | Examination Scheme                              |
| 6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 2                                                      | L: 02 Hrs/week  | CIE: 20 Marks<br>ISE: 20 Marks<br>ESE: 60 Marks |
| <b>Prerequisite: Students should have prior knowledge of</b> <ul style="list-style-type: none"><li>Fundamentals of Smart and Sustainable Systems, IoT for Smart and Sustainable Systems, Data Analytics for Smart and Sustainable Systems</li></ul>                                                                                                                                                                                                                                                                                                                                                              |                                                        |                 |                                                 |
| <b>Course Objectives: The objective of this course is to provide students with</b> <ul style="list-style-type: none"><li>Understanding of the core principles of cybersecurity, including the CIA Triad, threat modeling, and risk management, applied to the context of smart and sustainable systems.</li><li>Knowledge to recognize the security vulnerabilities, attack surfaces, and threat vectors present in interconnected smart environments.</li><li>Understanding of the role of advanced technologies in enhancing the security of smart systems.</li></ul>                                          |                                                        |                 |                                                 |
| <b>Course Outcomes: After completing this course, students will be able to:</b><br><b>CO1: Analyze</b> the vulnerabilities, threats and potential attack vectors in smart devices, networks, and platforms.<br><b>CO2: Analyze</b> appropriate mitigation strategies and security mechanisms for smart systems.<br><b>CO3: Apply</b> techniques to secure the data within smart systems.<br><b>CO4: Analyze</b> the use of emerging technologies to enhance cybersecurity in smart systems, and recognize associated security challenges.                                                                        |                                                        |                 |                                                 |
| COURSE CONTENTS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                        |                 |                                                 |
| Module I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Introduction to Security for Smart Systems             |                 | 8 Hrs                                           |
| Security challenges and attack surfaces in interconnected environments, Common attack vectors for smart devices (buffer overflows, injection attacks), Physical layer attacks (side-channel attacks, fault injection), Denial of Service (DoS) and Distributed DoS (DDoS) in smart systems, Confidentiality, Integrity, Availability (CIA Triad) in the context of smart systems. Authentication and Authorization mechanisms (device identity, access control). Non-repudiation and accountability. Threat modeling for smart systems (STRIDE, DREAD). Risk assessment and management for smart infrastructure. |                                                        |                 |                                                 |
| Module II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Cryptographic Techniques for Security of Smart Systems |                 | 6 Hrs                                           |
| Symmetric and Asymmetric Encryption (AES, RSA, ECC), Hashing algorithms and Digital Signatures. Lightweight cryptography for IoT devices (PRESENT, SIMON, SPECK), Key                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                        |                 |                                                 |

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| management challenges in distributed smart systems, Public Key Infrastructure (PKI) for device identity.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                          |              |
| <b>Module III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>Securing Connected Devices</b>                        | <b>6 Hrs</b> |
| Vulnerabilities in Common network protocols in smart systems, Firewalls, IDS/IPS for IoT, VPNs and secure tunnels for device communication, IoT device lifecycle security, secure boot, secure updates, Firmware security and secure coding practices, security of cloud platforms for IoT, Botnets of Things (e.g., Mirai) and their mitigation. Cyber-physical attacks on critical infrastructure, best practices for securing connected devices in IoT.                                                                                                                                                                                                                                                               |                                                          |              |
| <b>Module IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <b>Emerging Threats and Advanced Security Techniques</b> | <b>6 Hrs</b> |
| Emerging threats and research in smart system security, Secure design principles for smart systems, Security reference architectures for IoT, Relevant industry standards, NIST Cybersecurity Framework, OWASP IoT, Cybersecurity regulations for critical infrastructure protection, Role of AI, ML, Decentralized technologies in securing smart systems.                                                                                                                                                                                                                                                                                                                                                              |                                                          |              |
| <b>Text Books:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                          |              |
| <b>T1.</b> W. Stallings and L. Brown, <i>Computer Security: Principles and Practice</i> , 5th ed. Hoboken, NJ, USA: Pearson Education, 2021. ISBN: 978-0-13-809171-2.<br><b>T2.</b> R. Anderson, <i>Security Engineering: A Guide to Building Dependable Distributed Systems</i> , 3rd ed. Hoboken, NJ, USA: Wiley, Jan. 2021. ISBN: 978-1119642787.<br><b>T3.</b> R. Rajkumar <i>et al.</i> , <i>Cyber-Physical Systems: Foundations, Principles and Applications</i> . Boca Raton, FL, USA: CRC Press, 2016. ISBN: 9780133416152, 0133416151.<br><b>T4.</b> W. Stallings, <i>Network Security Essentials: Applications and Standards</i> , 6th ed. Hoboken, NJ, USA: Pearson Education, 2020. ISBN: 978-0-13-452733-8. |                                                          |              |
| <b>Reference Books:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                          |              |
| <b>R1.</b> E. D. Knapp, <i>Industrial Network Security</i> , 2nd ed. Waltham, MA, USA: Syngress, 2014. ISBN: 9780124201149.<br><b>R2.</b> OWASP Foundation, <i>OWASP IoT Project Documentation</i> . [Online]. Available: <a href="https://owasp.org/www-project-internet-of-things/">https://owasp.org/www-project-internet-of-things/</a> .                                                                                                                                                                                                                                                                                                                                                                            |                                                          |              |
| <b>Relevant MOOCs Courses:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                          |              |
| 1. Prof. Sudip Misra, "Introduction to Internet of Things", IIT Kharagpur, <a href="https://nptel.ac.in/courses/106105166">https://nptel.ac.in/courses/106105166</a><br>2. Prof. Saji K Mathew, "Cyber Security and Privacy", IIT Madras, <a href="https://nptel.ac.in/courses/106106248">https://nptel.ac.in/courses/106106248</a>                                                                                                                                                                                                                                                                                                                                                                                      |                                                          |              |
| <b>Relevant Topics for Self-study:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                          |              |
| 1. Case studies of real-world IoT/cyber-physical attacks (Mirai, Stuxnet, Jeep hack, Colonial Pipeline)<br>2. Wireshark analysis of IoT protocol packets<br>3. Honeypots for IoT research and attack intelligence<br>4. Authentication & authorization models (OAuth2, JWT, X.509 certs)                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                          |              |
| <b>Other Resources/Links:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                          |              |
| 1. <a href="https://www.tudelft.nl/cybersecurity/focus-areas/cyber-physical-systems">https://www.tudelft.nl/cybersecurity/focus-areas/cyber-physical-systems</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                          |              |



| Third Year B. Tech (T. Y B. Tech) AY (2026-27)<br>Computer Engineering (CE)<br>[2606MD31]-: Security for Smart and Sustainable Systems Laboratory<br>(SESSL)                                                                                                                                                                                                                                                               |                                                                                      |                 |                    |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|-----------------|--------------------|
| Semester                                                                                                                                                                                                                                                                                                                                                                                                                   | Credits                                                                              | Teaching Scheme | Examination Scheme |
| 6                                                                                                                                                                                                                                                                                                                                                                                                                          | 1                                                                                    | P: 02 Hrs/week  | CIE(TW): 25 Marks  |
| <b>Prerequisite: Students should have prior knowledge of</b> <ul style="list-style-type: none"><li>Foundation of Smart and Sustainable Systems</li></ul>                                                                                                                                                                                                                                                                   |                                                                                      |                 |                    |
| <b>Course Objectives: The objective of this course is to provide students with</b> <ul style="list-style-type: none"><li>Common vulnerabilities and potential attack vectors in smart devices, networks, and platforms.</li><li>Techniques for securing data within smart systems.</li><li>Use of emerging technologies to enhance cybersecurity in smart systems, and recognize associated security challenges.</li></ul> |                                                                                      |                 |                    |
| <b>Course Outcomes: After completing this course, students will be able to:</b><br><b>CO1: Apply</b> common authentication mechanisms to smart devices, networks, and platforms.<br><b>CO2: Implement</b> techniques for securing data within smart systems.<br><b>CO3: Implement</b> emerging technologies to enhance cybersecurity in smart systems, and recognize associated security challenges.                       |                                                                                      |                 |                    |
| Assignment List                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                      |                 |                    |
| Expt. No                                                                                                                                                                                                                                                                                                                                                                                                                   | Problem Statement                                                                    | CO's            |                    |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                          | Implement a basic user authentication system using Python.                           | CO1             |                    |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                          | Implement encrypted communications for sensor data.                                  | CO2             |                    |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                          | Store and retrieve encrypted data in the cloud.                                      | CO2             |                    |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                          | Implement techniques to anonymize data related to personal information, health etc.. | CO3             |                    |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                          | Mini-Project: Build a secure smart home automation system.                           | CO3             |                    |



| <b>Third Year B. Tech (T. Y B. Tech) AY (2026-27)</b><br><b>Computer Engineering (CE)</b><br><b>[2616VS31]: Seminar/Technical Presentation (STP)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                |                        |                           |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|------------------------|---------------------------|
| <b>Semester</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>Credits</b> | <b>Teaching Scheme</b> | <b>Examination Scheme</b> |
| <b>6</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>1</b>       | <b>P: 02 Hrs/week</b>  | <b>ESE(OR): 25 Marks</b>  |
| <b>Prerequisite: Students should have prior knowledge of</b><br>-NA-                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                |                        |                           |
| <b>Course Objectives: The objective of this course is to provide students with</b> <ul style="list-style-type: none"><li>● Explore the basic principles of communication (verbal and non-verbal) and techniques of active, empathetic listening, speaking, and writing.</li><li>● Explore the latest technologies and trends relevant to computer engineering.</li><li>● Enhance communication skills for professional success.</li><li>● Develop analytical and problem-solving skills through technical exploration.</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                |                        |                           |
| <b>Course Outcomes: After completing this course, students will be able to:</b><br><b>CO1: Analyze</b> and present the latest topic of professional interest.<br><b>CO2: Formulate</b> an engineering problem, and propose a viable work plan to solve it.<br><b>CO3: Demonstrate</b> enhanced technical writing skills through structured report writing.<br><b>CO4: Communicate</b> effectively with professional technical presentation skills.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                |                        |                           |
| <b>Guidelines :</b> <ul style="list-style-type: none"><li>● Batch size may consist of 9 to 10 students and will be conducted in 2 hours practical.</li><li>● <b>Topic Selection:</b><ul style="list-style-type: none"><li>○ Students will select a topic in the area of Computer Engineering and Technology, preferably focusing on recent technological trends and developments (beyond the regular syllabus).</li><li>○ Avoid repetition of topics in consecutive years.</li><li>○ Topic must be finalized in consultation with the Institute Guide.</li></ul></li><li>● <b>Seminar Presentation:</b><ul style="list-style-type: none"><li>○ Each group will deliver a 20-25 minute seminar presentation using audio/visual aids.</li><li>○ A well-prepared seminar report in LaTeX/Word format must be submitted.</li><li>○ Students are expected to actively participate in classmates' seminars.</li></ul></li><li>● <b>Seminar Logbook:</b><ul style="list-style-type: none"><li>○ Recommended to maintain a logbook for progress tracking, guide approval, and feedback.</li></ul></li></ul> |                |                        |                           |

**Guidelines for Assessment :**

Assessment will be carried out by a panel of staff members along with the guide based on the following parameters:

- Topic Relevance and Originality
- Content Quality and Depth of Research
- Presentation Skills (clarity, delivery, use of AV aids)
- Regularity, Punctuality, and Timely Completion
- Response in Question & Answer Session
- Quality of Report (LaTeX/Word formatting, plagiarism-free content)
- Paper Presentation / Publication (if any)
- Attendance and Active Participation

**Recommended Format of Seminar Report:****1. Title Page**

- Title of the topic
- Name of candidate with Exam Seat Number / Roll Number
- Name of the Guide
- Name of the Department, Institution, Year, and University

**2. Seminar Approval Sheet / Certificate****3. Abstract and Keywords****4. Acknowledgements****5. Table of Contents, List of Figures, List of Tables, Nomenclature****6. Chapters Covering the Topic**

- Introduction (including organization of the report)
- Literature Survey / Design or Technology Details / Analytical or Experimental Work
- Discussions and Conclusions
- Bibliography / References

**7. Plagiarism Check Report****8. Report Documentation Page**

## Best Practices & Expectations

- Plagiarism Policy:
  - Reports must have <10% similarity index as per plagiarism check.
  - Proper referencing using IEEE / APA format is mandatory.
- Report Quality:
  - The report must be written in LaTeX with consistent formatting, proper page numbering, figure/table captions, and well-organized sections.
  - Grammar and technical vocabulary must be precise and professional.
- Presentation Quality:
  - Use well-designed slides (legible font, minimal text, visuals preferred).
  - Maintain professional appearance and body language during the seminar.
  - Strictly adhere to 20–25 minutes duration.
- Active Participation:
  - Students must attend at least 80% of peer seminars and actively engage in Q&A sessions.
- Research Quality:
  - Encourage students to include at least 5–6 recent references (IEEE, Springer, ACM, or reputed journals/conferences).
  - If possible, students should explore mini experimental work, simulation, or prototype demonstration to strengthen their work.
- Soft Skills Development:
  - Promote time management by submitting milestones (topic selection, abstract, draft report) as per schedule.

## Reference Books:

- R1. Rebecca Stott, Cordelia Bryan, Tory Young, Speaking Your Mind: Oral Presentation and Seminar Skills (Speak-Write Series), Longman, ISBN-13: 978-0582382435, November 2000
- R2. Johnson-Sheehan, Richard, Technical Communication, Longman, ISBN: 0-321-11764-6, 2012
- R3. Vikas Shirodkar, Fundamental Skills for Building Professionals, SPD, ISBN: 978-93-5213-146-5, January 2015.



| Third Year B. Tech (T. Y B. Tech) AY (2026-27)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                  |                 |                                                |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|-----------------|------------------------------------------------|
| Computer Engineering (CE)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                  |                 |                                                |
| [2616PE11]: Machine Learning (ML)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                  |                 |                                                |
| Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Credits                          | Teaching Scheme | Examination Scheme                             |
| 6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 3                                | L: 03 Hrs/week  | CIE:20 Marks<br>ISE: 20 Marks<br>ESE: 60 Marks |
| <b>Prerequisite: Students should have prior knowledge of</b> <ul style="list-style-type: none"><li>Statistics, Fundamentals of Artificial Intelligence</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                  |                 |                                                |
| <b>Course Objectives: The objective of this course is to provide students with</b> <ul style="list-style-type: none"><li>Basics of machine learning types, and essential data preprocessing techniques for model development</li><li>Knowledge of supervised and unsupervised learning algorithms for solving problems and evaluating their performance</li><li>Knowledge in ensemble techniques and advanced deep learning architectures for developing predictive models</li></ul>                                                                                                                |                                  |                 |                                                |
| <b>Course Outcomes: After completing this course, students will be able to:</b><br><b>CO1: Choose</b> preprocessing techniques for a given problem.<br><b>CO2: Apply</b> classification, clustering, regression methods to solve problems.<br><b>CO3: Construct</b> association rules from frequent patterns.<br><b>CO4: Identify</b> ensemble methods, reinforcement learning, and artificial neural networks methods for given problems.                                                                                                                                                          |                                  |                 |                                                |
| COURSE CONTENTS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                  |                 |                                                |
| Module I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Introduction of Machine Learning |                 | 12 Hrs                                         |
| Introduction to Machine Learning: Definition, Applications, Types of Learning: Supervised, Unsupervised Learning, Reinforcement Learning, Semisupervised Learning. Data preprocessing: Need of data preprocessing, Data Cleaning, Data Integration and Transformation, Data Reduction, Discretization and Concept Hierarchy Generation, Handling of categorical data, Principal Component Analysis (PCA), Linear discriminant analysis (LDA), Non-Negative Matrix Factorization (NMF), Manifold Learning with t-SNE, Bias, and Variance.                                                            |                                  |                 |                                                |
| Module II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Supervised Learning Techniques   |                 | 9 Hrs                                          |
| Classification: Basic Concepts, Techniques: Naive Bayes, Decision Trees, Support Vector Machines (SVM), Random Forests, Logistic Regression, Classifying with K Nearest Neighbor. Regression: Simple and Multiple Linear Regression, Polynomial, Ridge and Lasso, Model selection for regression, Robust regression. Model Evaluation and Validation: Confusion matrix, Accuracy, Precision, Recall, Specificity, F1-Score, ROC-AUC, Cross-validation, Bias-variance tradeoff, MSE, R <sup>2</sup> .<br><b>Case Study:</b> Classification of spam email, Prediction of House Rent, Fraud detection. |                                  |                 |                                                |
| Module III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Unsupervised Learning Algorithms |                 | 9 Hrs                                          |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                      |              |
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| <p>Clustering: Introduction, Clustering methods: K-means Clustering, Agglomerative and Divisive Clustering, Density Based clustering (DBSCAN), Probabilistic Model based clustering (Expectation-Maximization algorithm). Model Evaluation and Validation: Elbow Method, Silhouette Score, Extrinsic and Intrinsic methods</p> <p>Mining frequent patterns: Basic concepts, Frequent Itemset Mining methods: Association Rule Mining, FP-Growth.</p> <p><b>Case Study:</b> Market Segmentation and Anomaly Detection.</p>                                                                                                                                                                           |                                                                      |              |
| <b>Module IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>Ensemble Methods, Reinforcement Learning, and Neural Networks</b> | <b>9 Hrs</b> |
| <p>Ensemble Methods: Bagging and Boosting (AdaBoost, Gradient Boosting, XGBoost)</p> <p>Reinforcement learning – Overview of Reinforcement, Learning, Scope of Reinforcement Learning, Reinforcement Learning As Machine Learning, Components of Reinforcement Learning, Markov Decision Process, Multi-Arm Bandit Problem and Reinforcement Problem Types</p> <p>Neural Network: Biological neuron, Artificial neuron, Activation functions, Architectures of neural network, Perceptron, Learning process in ANN, Back propagation.</p>                                                                                                                                                           |                                                                      |              |
| <b>Text Books:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                      |              |
| <p><b>T1.</b> E. Alpaydin, <i>Introduction to Machine Learning</i>, 2nd ed. New Delhi, India: PHI Learning, 2013. ISBN: 978-0-262-01243-0.</p> <p><b>T2.</b> K. P. Murphy, <i>Machine Learning: A Probabilistic Perspective</i>, 1st ed. Cambridge, MA, USA: MIT Press, 2012. ISBN: 978-0262306164.</p> <p><b>T3.</b> S. Sridhar and M. Vijayalakshmi, <i>Machine Learning</i>. New Delhi, India: Oxford University Press, 2021. ISBN: 978-0190127275.</p>                                                                                                                                                                                                                                          |                                                                      |              |
| <b>Reference Books:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                      |              |
| <p><b>R1.</b> J. Han, M. Kamber, and J. Pei, <i>Data Mining: Concepts and Techniques</i>, 3rd ed. Waltham, MA, USA: Elsevier, 2012. ISBN: 9780123814807.</p> <p><b>R2.</b> J. Sen, S. Mehtab, and A. Engelbrecht, <i>Machine Learning: Algorithms, Models and Applications</i>. Norderstedt, Germany: BoD–Books on Demand, 2021. ISBN: 978-1-83969-485-1.</p> <p><b>R3.</b> T. Hastie, R. Tibshirani, and J. Friedman, <i>The Elements of Statistical Learning: Data Mining, Inference, and Prediction</i>, 2nd ed. New York, NY, USA: Springer, 2009. ISBN: 978-0387848570.</p> <p><b>R4.</b> T. M. Mitchell, <i>Machine Learning</i>. New York, NY, USA: McGraw-Hill, 1997. ISBN: 0070428077.</p> |                                                                      |              |
| <b>Relevant MOOCs Courses:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                      |              |
| <ol style="list-style-type: none"> <li>1. Introduction to Machine Learning, IIT Madras, Prof. Balaraman Ravindran<br/><a href="https://nptel.ac.in/courses/106106139">https://nptel.ac.in/courses/106106139</a></li> <li>2. Introduction to Machine Learning, IIT Kharagpur, Prof. Sudeshna Sarkar<br/><a href="https://nptel.ac.in/courses/106105152">https://nptel.ac.in/courses/106105152</a></li> <li>3. Machine Learning with Python by IBM<br/><a href="https://cognitiveclass.ai/courses/machine-learning-with-python">https://cognitiveclass.ai/courses/machine-learning-with-python</a></li> </ol>                                                                                         |                                                                      |              |
| <b>Relevant Topics for Self-study:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                      |              |
| <ol style="list-style-type: none"> <li>1. Sklearn library functions</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                      |              |
| <b>Other Resources/Links:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                      |              |
| <ol style="list-style-type: none"> <li>1. <a href="https://www.openml.org/">https://www.openml.org/</a></li> <li>2. <a href="https://ml.gatech.edu/content/mlgt-labs">https://ml.gatech.edu/content/mlgt-labs</a></li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                      |              |



| Third Year B. Tech (T. Y B. Tech) AY (2026-27)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                              |                 |                                                 |
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| Computer Engineering (CE)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                              |                 |                                                 |
| [2616PE12]: Big Data Analytics (BDA)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                              |                 |                                                 |
| Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Credits                      | Teaching Scheme | Examination Scheme                              |
| 6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 3                            | L: 03 Hrs/week  | CIE: 20 Marks<br>ISE: 20 Marks<br>ESE: 60 Marks |
| Prerequisite: Students should have prior knowledge of                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                              |                 |                                                 |
| <ul style="list-style-type: none"><li>Data warehousing and Mining</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                              |                 |                                                 |
| Course Objectives: The objective of this course is to provide students with                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                              |                 |                                                 |
| <ul style="list-style-type: none"><li>Understand the basics of Data Science, Big data analytics life cycle and statistical foundations.</li><li>Learn predictive and descriptive analytics methods to find patterns in data and predict trends.</li><li>Knowledge of Big data Framework for big data storage and analysis.</li><li>Explore Apache Spark for real-time analytics to process and analyze streaming data.</li></ul>                                                                                                                                                                      |                              |                 |                                                 |
| Course Outcomes: After completing this course, students will be able to:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              |                 |                                                 |
| CO1: Apply Data Science and Big data analytics cycle to real world application.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                              |                 |                                                 |
| CO2: Analyze data trends using the predictive and descriptive analytics methods to discover the data.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                              |                 |                                                 |
| CO3: Illustrate large-scale data analytics using big data frameworks like Apache Hadoop                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                              |                 |                                                 |
| CO3: Design real time applications using Apache Spark.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                              |                 |                                                 |
| COURSE CONTENTS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                              |                 |                                                 |
| Module I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Foundation of Data Analytics |                 | 12 Hrs                                          |
| Basics and need of Data Science and Big Data, Characteristics of Big Data, Data Analytics Life Cycle, Data: Data Types, Data Collection. Need of Data wrangling, Methods: Data Cleaning, Data Integration, Data Reduction, Data Transformation, Data Discretization. Need of statistics in Big Data Analytics, Measures of Central Tendency: Mean, Median, Mode, Mid-range. Measures of Dispersion: Range, Variance, Mean Deviation, Standard Deviation. Bayes theorem, Basics and need of hypothesis & hypothesis testing, Pearson Correlation, Sample Hypothesis testing, Chi-Square Tests, t-test. |                              |                 |                                                 |
| Module II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Data Analytic algorithms     |                 | 9 Hrs                                           |
| Predictive Analytics: Regression: Linear Regression, Logistic Regression. Classification: Naïve Bayes, Decision Trees, Support Vector Machine, Evaluation, Ensemble methods. Descriptive Analytics: Clustering algorithm , Association rule mining, Evaluation.                                                                                                                                                                                                                                                                                                                                       |                              |                 |                                                 |

| Module III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Big Data Framework            | 9 Hrs |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|-------|
| Data Placement Strategies: Simple and Network Topology based strategy. Hadoop Ecosystem: Architecture, Hadoop Distributed File System (HDFS), MapReduce ,YARN, HBase. Hive and Pig: Hive Services, Query language for Hive, Pig Architecture, Properties and operators in PIG.                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                               |       |
| Module IV                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Big Data Analytics with Spark | 9 Hrs |
| APACHE SPARK: Spark Architecture, RDD, MLlib, Graph Analytics for Big Data and Spark GraphX Platform, Real-time Analytics Platform (RTAP)-SparkStreaming, Interactive Data Analysis with Spark Shell, Scala for Data Scientists. Case Study: Social Network Analytics using Spark                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                               |       |
| <b>Text Books:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                               |       |
| <b>T1.</b> DT Editorial Services, <i>Big Data Black Book: Covers Hadoop 2, MapReduce, Hive, YARN, Pig, R and Data Visualization</i> . New Delhi, India: Dreamtech Press, 2016. ISBN: 978-8184891430.<br><b>T2.</b> B. Baesens, <i>Analytics in a Big Data World: The Essential Guide to Data Science and Its Applications</i> . Hoboken, NJ, USA: Wiley, 2014. ISBN: 978-1118892749.<br><b>T3.</b> J. Leskovec, A. Rajaraman, and J. D. Ullman, <i>Mining of Massive Datasets</i> . Cambridge, U.K.: Cambridge University Press, 2020. ISBN: 978-1108476348.<br><b>T4.</b> M. Guller, <i>Big Data Analytics with Spark: A Practitioner's Guide to Using Spark for Large-Scale Data Analysis</i> . New York, NY, USA: Apress, 2015. ISBN: 978-1484209653. |                               |       |
| <b>Reference Books:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                               |       |
| <b>R1.</b> F. Kane, <i>Hands-On Data Science and Python Machine Learning</i> . Birmingham, U.K.: Packt Publishing, 2017.<br><b>R2.</b> B. Baesens, <i>Analytics in a Big Data World: The Essential Guide to Data Science and Its Applications</i> . Hoboken, NJ, USA: John Wiley & Sons, 2014. ISBN: 978-1118892701.<br><b>R3.</b> S. Ryza, U. Laserson, S. Owen, and J. Wills, <i>Advanced Analytics with Spark: Patterns for Learning from Data at Scale</i> . Sebastopol, CA, USA: O'Reilly Media, 2017. ISBN: 978-1491912768.<br><b>R4.</b> DT Editorial Services, <i>Big Data Black Book: Covers Hadoop 2, MapReduce, Hive, YARN, Pig, R and Data Visualization</i> . New Delhi, India: Dreamtech Press, 2016. ISBN: 978-8184891430.                |                               |       |
| <b>Relevant MOOCs Courses:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                               |       |
| 1. Big Data Computing, By Prof. Rajiv Misra<br><a href="https://onlinecourses.nptel.ac.in/noc20_cs92/preview">https://onlinecourses.nptel.ac.in/noc20_cs92/preview</a><br>2. Data Analytics with Python, By Prof. A Ramesh<br><a href="https://onlinecourses.nptel.ac.in/noc21_cs45/preview">https://onlinecourses.nptel.ac.in/noc21_cs45/preview</a>                                                                                                                                                                                                                                                                                                                                                                                                    |                               |       |
| <b>Relevant Topics for Self-study:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                               |       |
| Apache Kafka                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                               |       |

**Other Resources/Links:**

1. Big Data Analytics by Raj Kamal,  
<https://jcer.in/jcer-docs/E-Learning/Digital%20Library%20/E-Books/Big%20Data%20Analytics%20by%20Raj%20Kamal,%20Preethi%20Saxena,TMH.pdf>
2. White, T. (2012). Hadoop: The definitive guide. O'Reilly Media, Inc,  
<https://piazza-resources.s3.amazonaws.com/ist3pwd6k8p5t/iu5gqbsh8re6mj/OReillyHadoop.The.Definitive.Guide.4th.Edition.2015.pdf>



| Third Year B. Tech (T. Y B. Tech) AY (2026-27)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                    |                 |                                                 |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|-----------------|-------------------------------------------------|
| Computer Engineering (CE)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                    |                 |                                                 |
| [2616PE13]: Human Computer Interaction (HCI)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                    |                 |                                                 |
| Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Credits                            | Teaching Scheme | Examination Scheme                              |
| 6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 03                                 | L: 03 Hrs/week  | CIE: 20 Marks<br>ISE: 20 Marks<br>ESE: 60 Marks |
| Prerequisite: Students should have prior knowledge of                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                    |                 |                                                 |
| <ul style="list-style-type: none"><li>• Software Engineering, Computer Graphics</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                    |                 |                                                 |
| Course Objectives: The objective of this course is to provide students with                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                    |                 |                                                 |
| <ul style="list-style-type: none"><li>• Understand the basics of HCI, human capabilities, and the role of HCI design principles in the software development process and information technology.</li><li>• Explore interaction paradigms and learn prototyping techniques.</li><li>• Learn to analyze users and design accessible systems.</li><li>• Conduct usability evaluation and explore emerging trends.</li></ul>                                                                                                                                                                                                                                                                                                         |                                    |                 |                                                 |
| Course Outcomes: After completing this course, students will be able to:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                    |                 |                                                 |
| CO1: Design interfaces for certain user groups and according to users' context and needs.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                    |                 |                                                 |
| CO2: Apply user-centered design strategies, data gathering techniques, rapid prototyping tools, and methods                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                    |                 |                                                 |
| CO3: Assess the effectiveness and user-friendliness of various interaction designs.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                    |                 |                                                 |
| CO4: Analyze the requirements for interface design of mobile and other handheld devices.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                    |                 |                                                 |
| COURSE CONTENTS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                    |                 |                                                 |
| Module I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Foundations of HCI                 |                 | 12 Hrs                                          |
| Introduction to HCI: History and evolution, Importance of usability and user experience, Basic interaction models (human, computer, interaction) Human Capabilities: Human perception: vision, hearing, Cognition: memory, attention, mental models, motor skills and physical interaction limitations, Relation to Ergonomics and Human Factors, Design Principles & Usability: Norman's design principles (affordances, feedback, constraints), Schneiderman's Eight Golden Rules, Usability goals and heuristics. Introduction to User-Centered Design (UCD): UCD process overview, Know your user: User research techniques: interviews, surveys, Personas and scenarios, Ethical considerations in human factors research. |                                    |                 |                                                 |
| Module II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Interaction Styles and Prototyping |                 | 9 Hrs                                           |

Interaction Styles: Command-line, menus, direct manipulation, touch, gesture, voice interaction, Emerging paradigms: AR/VR basics. Affordances and Feedback in Interfaces: Mapping and constraints, Visual, auditory, and haptic feedback. Prototyping Techniques: Low-fidelity prototyping (paper sketches, storyboards), High-fidelity prototyping (wireframes, interactive mockups), Tools overview (Figma, Balsamiq, Adobe XD). Introduction to Usability Testing: Types of usability tests, Planning and conducting tests, Think-aloud protocol basics.

| Module III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | User Analysis and Accessibility | 9 Hrs |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|-------|
| <p>Task Analysis: Hierarchical Task Analysis (HTA), Use cases and user stories, User workflows and scenarios. User Models: Cognitive models (GOMS), Mental models vs. system models. Accessibility Principles: Designing for disabilities (visual, auditory, motor, cognitive), Accessibility guidelines (WCAG basics), Tools and techniques for accessible design. Mobile and Web Usability: Responsive design principles, Mobile UX patterns and challenges, Accessibility on mobile devices. Case study: Design a Task Flow Diagram for an online food ordering system such as Swiggy. The goal is to analyze how a user places an order through the mobile app.</p>                                                                                                                                                    |                                 |       |
| Module IV                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Evaluation and Trends           | 9 Hrs |
| <p>Usability Evaluation Methods: Heuristic evaluation, Cognitive walkthroughs, Quantitative and qualitative metrics. Data Collection &amp; Analysis: A/B testing fundamentals, User behavior analytics (logs, heatmaps), Interpreting usability data. Emerging Trends in HCI: AI-powered interfaces, HCI with IOT Applications, Conversational UI: Chatbot, voice assistants, Future interfaces: Brain-Computer Interfaces, wearables.</p> <p>BPMN in HCI: Introduction to Business Process Model and Notation (BPMN) for modeling user-system interaction workflows; Core elements-events, tasks, gateways, sequence flows, pools and lanes; Model BPMN using real-world examples (ATM/Library/E-commerce) and evaluating usability improvements in the process design.</p>                                               |                                 |       |
| Text Books:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                 |       |
| <p><b>T1.</b> H. Sharp, Y. Rogers, and J. Preece, <i>Interaction Design: Beyond Human-Computer Interaction</i>, 4th ed. Hoboken, NJ, USA: Wiley, 2019. ISBN: 978-1119547256.</p> <p><b>T2.</b> A. Dix, J. Finlay, G. D. Abowd, and R. Beale, <i>Human-Computer Interaction</i>, 3rd ed. Upper Saddle River, NJ, USA: Pearson, 2003. ISBN: 978-0130461097.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                 |       |
| Reference Books:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                 |       |
| <p><b>R1.</b> B. Shneiderman, C. Plaisant, M. Cohen, and S. Jacobs, <i>Designing the User Interface: Strategies for Effective Human-Computer Interaction</i>, 6th ed. Boston, MA, USA: Pearson, 2016. ISBN: 978-0134380384.</p> <p><b>R2.</b> A. Cooper, R. Reimann, D. Cronin, and C. Noessel, <i>About Face: The Essentials of Interaction Design</i>, 4th ed. Hoboken, NJ, USA: Wiley, Sep. 2014. ISBN: 978-1118766576.</p> <p><b>R3.</b> J. Johnson, <i>Designing with the Mind in Mind: A Simple Guide to Understanding User Interface Design Guidelines</i>, 2nd ed. Waltham, MA, USA: Morgan Kaufmann, 2014. ISBN: 978-0124079144.</p> <p><b>R4.</b> C. Jarrett and G. Gaffney, <i>Usability Testing Essentials: Ready, Set...Test!</i>, 1st ed. Waltham, MA, USA: Morgan Kaufmann, 2008. ISBN: 978-0123740950.</p> |                                 |       |

**R5.** J. Nielsen and R. L. Mack, Eds., *Usability Inspection Methods*, 1st ed. Hoboken, NJ, USA: Wiley, 1994. ISBN: 978-0470601989.

**Relevant MOOCs Courses:**

1. Human Computer Interaction By Prof. Rajiv Ratn Shah-IIIT Delhi  
[https://onlinecourses.nptel.ac.in/noc25\\_cs38/preview](https://onlinecourses.nptel.ac.in/noc25_cs38/preview)

**Relevant Topics for Self-study:**

1. Role of HCI in IoT: Case Study: Smart Home Energy Management System (SHEMS)
2. HCI + LLM Design Aspects
3. HCI Perspective on Privacy & Security: Case Study: Facebook's Privacy Interface Redesign (2018-2020)

**Other Resources/Links:**

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| Third Year B. Tech (T. Y B. Tech) AY (2026-27)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                          |                 |                                                 |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------|-----------------|-------------------------------------------------|
| Computer Engineering (CE)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                          |                 |                                                 |
| [2616PE14]: Software Defined Networks (SDN)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                          |                 |                                                 |
| Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Credits                                  | Teaching Scheme | Examination Scheme                              |
| 6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 3                                        | L: 03 Hrs/week  | CIE: 20 Marks<br>ISE: 20 Marks<br>ESE: 60 Marks |
| Prerequisite: Students should have prior knowledge of <ul style="list-style-type: none"><li>• Computer Networks and Security</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                          |                                          |                 |                                                 |
| Course Objectives: The objective of this course is to provide students with <ul style="list-style-type: none"><li>• Learn the fundamentals of software defined networks.</li><li>• Explore different controllers of SDN.</li><li>• Learn the fundamentals about SDN programming.</li><li>• Analyze the various application of SDN</li></ul>                                                                                                                                                                                                                     |                                          |                 |                                                 |
| Course Outcomes: After completing this course, students will be able to:<br>CO1:Differentiate between traditional and software defined networks.<br>CO2: Associate appropriate controllers for different applications.<br>CO3: Learn how to use software programs to perform varying and complex networking tasks.<br>CO4: Explore the knowledge learned and apply it to solve real time problems.                                                                                                                                                              |                                          |                 |                                                 |
| COURSE CONTENTS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                          |                 |                                                 |
| Module I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Introduction to Software Defined Network |                 | 12 Hrs                                          |
| Challenges of traditional networks, History of Software Defined Networking (SDN), Modern Data Center – Traditional Switch Architecture – Why SDN – Evolution of SDN – How SDN Works – Centralized and Distributed Control and Data Planes. Moving Information between Data Planes, Distributed Control Planes – IP and MPLS – Creating IP Underlay – Convergence Time – Load Balancing – High availability – creating the MPLS overlay – Replication – Centralized Control Planes – ATM/LANE – Route Servers. Exemplar/Case Studies: Video Streaming.           |                                          |                 |                                                 |
| Module II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Open Flow and Controllers                |                 | 9 Hrs                                           |
| Network Operating System (NOS). SDN Architecture. Open Flow Overview, The Open Flow Switch, The Open Flow Controller, Open Flow Ports, Message Types, Pipeline Processing, Flow Tables, Matching, Instructions, Action Set and List, Open Flow Protocol, Proactive and Reactive Flow, Timers, Open Flow Limitations, Open Flow Advantages and Disadvantages, Open v Switch Features, Drawbacks of Open SDN, Introduction to SDN controller. Exemplar/Case Studies: Behavior Anomaly Detection in SDN Control Plane: A Case Study of Topology Discovery Attacks. |                                          |                 |                                                 |
| Module III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | SDN Security                             |                 | 9 Hrs                                           |

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|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|--------------|
| SDN-Specific Security Challenges, Security Principles, Threat vectors in SDN architecture - Attacks at Data Plane Layer, Attacks at Controller Layer, Attacks at SDN Layer, SDN Security framework - Securing the Data Plane Layer, Securing the Controller Layer, Securing the SDN Layer. General Security Hardening Components, Security Techniques- Firewall, Intrusion Detection System. Exemplar/Case Studies: A Yotta Infrastructure case study.                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                        |              |
| <b>Module IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>SDN Programming</b> | <b>9 Hrs</b> |
| Programming SDNs: Northbound Application Programming Interface, Current Languages and Tools, Composition of SDNs – Introduction of Network Functions Virtualization (NFV) and Software Defined Networks: Concepts, Implementation and Applications. Exemplar/Case Studies: Ballarat Grammar uses SDN to fight malware.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                        |              |
| <b>Text Books:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                        |              |
| <p><b>T1.</b> P. Goransson and C. Black, <i>Software Defined Networks: A Comprehensive Approach</i>. Waltham, MA, USA: Morgan Kaufmann, 2014. ISBN: 9780124166752, 9780124166844.</p> <p><b>T2.</b> S. Azodolmolky, <i>Software Defined Networking with OpenFlow</i>. Birmingham, U.K.: Packt Publishing, 2013. ISBN: 9781849698726.</p> <p><b>T3.</b> T. D. Nadeau and K. Gray, <i>SDN: Software Defined Networks – An Authoritative Review of Network Programmability Technologies</i>. Sebastopol, CA, USA: O'Reilly Media, 2013. ISBN-10: 1449342302, ISBN-13: 978-1449342302.</p>                                                                                                                                                                                                                                                                                                                                               |                        |              |
| <b>Reference Books:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                        |              |
| <p><b>R1.</b> V. Tiwari, <i>SDN and Open Flow for Beginners</i>. Seattle, WA, USA: Amazon Digital Services, Inc., 2013. ISBN-13: 978-0198093480.</p> <p><b>R2.</b> F. Hu, Ed., <i>Network Innovation through OpenFlow and SDN: Principles and Design</i>. Boca Raton, FL, USA: CRC Press, 2014. ISBN-10: 1466572094.</p> <p><b>R3.</b> Open Networking Foundation (ONF), "ONF Technical Documents," 2015. [Online]. Available: <a href="https://www.opennetworking.org">https://www.opennetworking.org</a>.</p>                                                                                                                                                                                                                                                                                                                                                                                                                      |                        |              |
| <b>Other Resources/Links:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                        |              |
| <ol style="list-style-type: none"> <li>1. <a href="https://ridhanegara.staff.telkomuniversity.ac.id/files/2017/04/Paul-Goransson-andChuck-Black-Auth.-Software-Defined-Networks.-A-Comprehensive-Approach.pdf">https://ridhanegara.staff.telkomuniversity.ac.id/files/2017/04/Paul-Goransson-andChuck-Black-Auth.-Software-Defined-Networks.-A-Comprehensive-Approach.pdf</a></li> <li>2. <a href="https://speetis.fei.tuke.sk/KomunikacnaTechnika1/prednasky/7_11_2016/kniha_sietovanie.pdf">https://speetis.fei.tuke.sk/KomunikacnaTechnika1/prednasky/7_11_2016/kniha_sietovanie.pdf</a></li> <li>3. <a href="https://ridhanegara.staff.telkomuniversity.ac.id/files/2017/04/Thomas-D.-Nadeau-KenGray-SDN-Software-Defined-Networks-O_039_Reilly-Media-2013.pdf">https://ridhanegara.staff.telkomuniversity.ac.id/files/2017/04/Thomas-D.-Nadeau-KenGray-SDN-Software-Defined-Networks-O_039_Reilly-Media-2013.pdf</a></li> </ol> |                        |              |
| <b>Relevant MOOCs Courses:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                        |              |
| <ol style="list-style-type: none"> <li>1. "Basics of Software Defined Radios and Practical Applications" , Prof. Meenakshi Rawat, IIT Roorkee. <a href="https://nptel.ac.in/courses/108107107">https://nptel.ac.in/courses/108107107</a></li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                        |              |
| <b>Relevant Topics for Self-study:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                        |              |
| <ol style="list-style-type: none"> <li>1. Explore Northbound APIs for application development and Southbound APIs (like OpenFlow) for switch communication.</li> <li>2. Investigate DDoS mitigation techniques, controller security, and securing the control-data plane interface.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                        |              |



| Third Year B. Tech (T. Y B. Tech) AY (2026-27)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                      |                 |                                                 |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------|-----------------|-------------------------------------------------|
| Computer Engineering (CE)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                      |                 |                                                 |
| [2616PE15]: Cyber Security (CS)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                      |                 |                                                 |
| Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Credits                              | Teaching Scheme | Examination Scheme                              |
| 6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 3                                    | L: 03 Hrs/week  | CIE: 20 Marks<br>ISE: 20 Marks<br>ESE: 60 Marks |
| <b>Prerequisite: Students should have prior knowledge of</b> <ul style="list-style-type: none"><li>Computer Networks and Cryptography</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                      |                 |                                                 |
| <b>Course Objectives: The objective of this course is to provide students with</b> <ol style="list-style-type: none"><li>Fundamentals of cybercrime, cybercriminals, attack methods, and precautionary measures for personal, organizational, and societal security.</li><li>Knowledge of cybersecurity standards, frameworks, and tools for risk assessment, mitigation, and network defense.</li><li>Basics of Open-Source/trial security tools for detecting, preventing, and analyzing cyber threats across different platforms.</li><li>Emerging trends in cybersecurity including AI, IoT, Cloud, and data privacy, preparing learners for careers in the cybersecurity domain.</li></ol> |                                      |                 |                                                 |
| <b>Course Outcomes: After completing this course, students will be able to:</b> <p><b>CO1: Classify</b> various types of cyber crimes, cybercriminals, attacks strategies &amp; recommend their precautionary measures</p> <p><b>CO2: Summarize</b> the cyber security framework &amp; discuss the legal aspects w.r.t. IT Act</p> <p><b>CO3: Compare</b> and evaluate network defense tools and security protocols (such as IPsec and SSL/TLS) in terms of their effectiveness in mitigating and preventing cyber attacks</p> <p><b>CO4: Discuss</b> emerging security trends including cloud security, IoT security, and the role of AI/ML in cybersecurity.</p>                              |                                      |                 |                                                 |
| COURSE CONTENTS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                      |                 |                                                 |
| Module I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Introduction                         |                 | 12 Hrs                                          |
| Introduction to Cybercrime & precautionary measures: Cybercrime & Information Security, Who are Cybercriminals?, classification of cybercrimes, Cyberoffenses, how criminals plan attacks, social engineering, cyberstalking, Cybercafe & Cybercrimes, Botnets – The fuel of cybercrime, Attack vector, cybercrimes & risks associated with cloud computing, Cybercrime in Mobile & wireless devices, popular types of attacks against mobile networks, credit card frauds in mobile & wireless computing era, attacks on mobile / cell phones, Organizational security policies & measures in mobile computing era. Careers in cybersecurity.                                                  |                                      |                 |                                                 |
| Module II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Cyber Crime Issues and Cyber attacks |                 | 8 Hrs                                           |
| Unauthorized Access to Computers, Computer Intrusions, Viruses, and Malicious Code, Internet Hacking and Cracking, Virus and worms, Software Piracy, Intellectual Property, Mail Bombs,                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                      |                 |                                                 |

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|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------|--------------|
| <p>Exploitation, Stalking and Obscenity in Internet, Cybercrime prevention methods, Application security (Database, E-mail, and Internet), Data Security Considerations-Backups, Archival Storage and Disposal of Data, Security Technology-Firewall and VPNs, Hardware protection mechanisms, OS Security</p> <p>Certified Information Systems Security Professional (CISSP): Security domains, National Institute of Standards and Technology (NIST) Cybersecurity Framework: Risk Management Framework (RMF), National Institute of Standards and Technology (NIST). Inheriting security problems, factoring risks from processes. Mitigating exposures. IT Act</p>                                                                                                              |                                                  |              |
| <b>Module III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>Network Security Protocols</b>                | <b>9 Hrs</b> |
| <p>Securing network layers with SSL/TLS and IPsec: IPsec architecture, modes, security association (SA). Encapsulating Security Payload (ESP), Authentication Header (AH), Internet key exchange (IKE) – Internet Security Association and Key Management Protocol (ISAKMP). Security at Transport layer SSL handshake protocol, Open SSL. IEEE 802.11 Wireless LAN security. Network Defense Tools: Firewalls (packet filtering, stateful inspection), Intrusion Detection Systems (IDS), and Intrusion Prevention Systems (IPS). Common Network Attacks: Denial-of-Service (DoS), Man-in-the-Middle (MitM) attacks, sniffing, and spoofing.</p>                                                                                                                                   |                                                  |              |
| <b>Module IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>Application Security and Modern Practices</b> | <b>9 Hrs</b> |
| <p>Software Security: Secure Software Development Lifecycle (SSDLC). Principles of secure coding (e.g., input validation, error handling). Malicious Software (Malware): Viruses, worms, trojans, ransomware, and spyware. Emerging Trends: A brief overview of Cloud Security, IoT Security, and the role of AI/ML in cybersecurity. Data Security in AI, Data Security: Protecting data used for AI training and operation from unauthorized access, tampering, and theft. Encryption: Ensuring data is encrypted both in transit and at rest to prevent unauthorized access. Access Control: Implementing strict access controls to limit who can view or manipulate data. Privacy in AI, Privacy: Safeguarding the privacy of individuals whose data is used by AI systems.</p> |                                                  |              |
| <b>Text Books:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                  |              |
| <p><b>T1.</b> W. Stallings, <i>Cryptography and Network Security: Principles and Practice</i>, 7th ed. Boston, MA, USA: Pearson, Jun. 2017. ISBN: 978-1292158582.</p> <p><b>T2.</b> B. A. Forouzan and D. Mukhopadhyay, <i>Cryptography and Network Security</i>, 2nd ed. New Delhi, India: Tata McGraw-Hill (TMH), Jul. 2010. ISBN: 978-0070702086.</p> <p><b>T3.</b> N. Doraswamy and D. Harkins, <i>IPSec: The New Security Standard for the Internet, Intranets, and Virtual Private Networks</i>, 2nd ed. Upper Saddle River, NJ, USA: Pearson Education, 2003. ISBN-10: 0130118982, ISBN-13: 978-0130118981.</p>                                                                                                                                                              |                                                  |              |
| <b>Reference Books:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                  |              |
| <p><b>R1.</b> N. Godbole, <i>Information Systems Security: Security Management, Metrics, Frameworks and Best Practices</i>. New Delhi, India: Wiley India, Jan. 2017.</p> <p><b>R2.</b> C. P. Pfleeger and S. L. Pfleeger, <i>Security in Computing</i>. Upper Saddle River, NJ, USA: Prentice Hall, Aug. 2023.</p> <p><b>R3.</b> D. Stuttard and M. Pinto, <i>The Web Application Hacker's Handbook: Finding and Exploiting Security Flaws</i>. Indianapolis, IN, USA: Wiley Publishing.</p> <p><b>R4.</b> A. Fadia and M. Zacharia, <i>Intrusion Alert: An Ethical Hacking Guide to Intrusion Detection</i>. New Delhi, India: Vikas Publishing.</p>                                                                                                                              |                                                  |              |

**R5.** A. Kahate, *Cryptography and Network Security*, 3rd ed. New Delhi, India: McGraw Hill Education, Jul. 2017.  
**R6.** V. K. Pachghare, *Cryptography and Information Security*, 2nd ed. New Delhi, India: PHI Learning, Mar. 2015. ISBN: 978-81-203-5082-3.

**Relevant MOOCs Courses:**

1. Cryptography and Network Security Prof. Sourav Mukhopadhyay, IIT Kharagpur  
[https://onlinecourses.nptel.ac.in/noc20\\_cs21/preview](https://onlinecourses.nptel.ac.in/noc20_cs21/preview)

**Other Resources/Links:**

1. <https://ocw.mit.edu/courses/>

**Relevant Topics for Self-study:**

1. Study and analyze any two recent cybercrime cases (e.g., WannaCry ransomware, phishing, identity theft viz; Aadhaar data breach). Identify the attack vectors, tools/techniques used, and propose suitable countermeasure
2. Read article from magazine: Identity is the new must have security perimeter for Indian enterprises
3. Strengths & limitations of Indian ITA 2000. is it overcome by 2008 amendments to the Act.
4. Data Breach Digest – Perspective & Reality :  
<http://verizonenterprise.com/databreachdigest>



| Third Year B. Tech (T. Y B. Tech) AY (2026-27)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                               |                 |                                               |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------|-----------------|-----------------------------------------------|
| Computer Engineering (CE)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                               |                 |                                               |
| [2616PE21] Natural Language Processing (NLP)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                               |                 |                                               |
| Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Credits                                       | Teaching Scheme | Examination Scheme                            |
| 6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 3                                             | L: 03 Hrs/week  | CIE: 20Marks<br>ISE: 20 Marks<br>ESE: 60Marks |
| Prerequisite: Students should have prior knowledge of                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                               |                 |                                               |
| <ul style="list-style-type: none"><li>Basic Mathematics, Basics of Deep learning</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                               |                 |                                               |
| Course Objectives: The objective of this course is to provide students with                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                               |                 |                                               |
| <ul style="list-style-type: none"><li>Understand the fundamental concepts and statistical properties of text documents.</li><li>Develop the ability to represent, manipulate, and model linguistic data for various tasks.</li><li>Learn the language model for various applications.</li></ul>                                                                                                                                                                                                                                                                                                           |                                               |                 |                                               |
| Course Outcomes: After completing this course, students will be able to:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                               |                 |                                               |
| CO1: Apply basic text processing techniques and statistical properties in NLP.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                               |                 |                                               |
| CO2: Analyse the performance of Part-of-Speech taggers and parsing techniques in NLP.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                               |                 |                                               |
| CO3: Apply word embedding techniques on text data                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                               |                 |                                               |
| CO4: Choose appropriate language model for NLP applications                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                               |                 |                                               |
| COURSE CONTENTS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                               |                 |                                               |
| Module I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Introduction to NLP and Basic Text Processing |                 | 12 Hrs                                        |
| Introduction: Stages of NLP, Applications of NLP, Empirical Laws of language, zipf's law, Heap's law. Words and Tokens: Words, Morphen, Tokenization, normalization, case folding, Spelling Correction, Morphology, Stemming, Porters Algorithm, lemmatization, N-gram Language Modeling.                                                                                                                                                                                                                                                                                                                 |                                               |                 |                                               |
| Module II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Annotating Linguistic Structure               |                 | 9 Hrs                                         |
| POS Tagging and Named Entities: Part-of-Speech Tagging, Named Entities and Named Entity Tagging, HMM Part-of-Speech Tagging, Conditional Random Fields (CRFs) , Evaluation. Dependency Parsing: Dependency Relations, Transition-Based Dependency Parsing, Graph-Based Dependency Parsing, Evaluation. Semantic Role labelling: Semantic roles, FrameNet. Coreference Resolution: Mention Detection, Architectures for Coreference Algorithms, A neural mention-ranking algorithm, Entity Linking, Evaluation. Discourse Coherence: Representation learning models for local coherence, Global Coherence. |                                               |                 |                                               |

| Module III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Word embeddings and Neural network for NLP | 9 Hrs |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------|-------|
| Word embeddings : Lexical semantics, Vector semantics, Similarity measures, Word2Vec, visualizing embeddings, FastText, Word embedding for regional languages, evaluation. Neural Network: Feedforward Neural Networks, Feedforward network for NLP, Embeddings as the input to neural net classifiers, training. Transformers: Transformer blocks, Self-attention Mechanism, Sub-word tokenization, Positional encoding. Case study: Document Summarization.                                                                                                                                                                                                                                                                                           |                                            |       |
| Module IV                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Masked Language and Retrieval based model  | 9 Hrs |
| Masked Language model: Bidirectional Transformer Encoders, Contextual Embeddings. Fine-Tuning for Classification, Fine-Tuning for Sequence Labelling: Named Entity Recognition, Pre-trained Language Models (PLMs): BERT, GPT. Retrieval based models: Information Retrieval with Dense vector, Answering questions using RAG, evaluation. Machine translation: Language Divergences and Typology, Machine Translation using Encoder-Decoder. NLP using Graph: Representation and modelling using graph. Case study: Text to Speech.                                                                                                                                                                                                                    |                                            |       |
| <b>Text Books:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                            |       |
| <b>T1.</b> D. Jurafsky and J. H. Martin, <i>Speech and Language Processing</i> , 3rd ed. New Delhi, India: Pearson Education, 2020. ISBN: 978-9332518414.<br><b>T2.</b> C. D. Manning and H. Schütze, <i>Foundations of Statistical Natural Language Processing</i> . Cambridge, MA, USA: MIT Press, 1999. ISBN: 9780262133609.                                                                                                                                                                                                                                                                                                                                                                                                                         |                                            |       |
| <b>Reference Books:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                            |       |
| <b>R1.</b> S. Vajjala, B. Majumder, A. Gupta, and H. Surana, <i>Practical Natural Language Processing</i> , 1st ed. Sebastopol, CA, USA: O'Reilly Media, 2020. ISBN-10: 1492054054.<br><b>R2.</b> H. Lane, C. Howard, and H. Hapke, <i>Natural Language Processing in Action</i> . Shelter Island, NY, USA: Manning Publications, 2019. ISBN: 9781617294631.<br><b>R3.</b> J. Alammur and M. Grootendorst, <i>Hands-On Large Language Models: Language Understanding and Generation</i> , 1st ed. Sebastopol, CA, USA: O'Reilly Media, 2024. ISBN: 9781098150969.<br><b>R4.</b> S. Raschka, <i>Build a Large Language Model (From Scratch)</i> , 1st ed. New York, NY, USA: Simon & Schuster, 2024. ISBN: 9781633437166.                                |                                            |       |
| <b>Relevant MOOCs Courses:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                            |       |
| 1. NPTEL on Natural Language processing , Pavan Goyal , IIT kharagpur<br><a href="https://nptel.ac.in/courses/106105158">https://nptel.ac.in/courses/106105158</a><br>2. Natural Language Processing, IIT Bombay, Prof. Pushpak Bhattacharyya<br><a href="https://nptel.ac.in/courses/106101007">https://nptel.ac.in/courses/106101007</a><br>3. NOC: Applied Natural Language Processing, Chennai Mathematical Institute<br>Prof. Ramaseshan R <a href="https://nptel.ac.in/courses/106106211">https://nptel.ac.in/courses/106106211</a><br>4. Natural Language Processing and Large Language Models, Hugging face course<br><a href="https://huggingface.co/learn/llm-course/en/chapter1/2">https://huggingface.co/learn/llm-course/en/chapter1/2</a> |                                            |       |
| <b>Relevant Topics for Self-study:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                            |       |
| GraphRAG, Knowledge graph                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                            |       |

**Other Resources/Links:**

1. <https://www.nltk.org/book/>
2. Natural Language toolkit <https://www.nltk.org/>
3. Huggingface models  
<https://huggingface.co/models?other=natural+language+processing>

PICT CETY 2026-27



| Third Year B. Tech (T. Y B. Tech) AY (2026-27)                                                                                                                                                                                                                                                                                                                                                                                                                            |                                            |                 |                                                 |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------|-----------------|-------------------------------------------------|
| Computer Engineering (CE)                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                            |                 |                                                 |
| [2616PE22]: Embedded Operating Systems (EOS)                                                                                                                                                                                                                                                                                                                                                                                                                              |                                            |                 |                                                 |
| Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Credits                                    | Teaching Scheme | Examination Scheme                              |
| 6                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 3                                          | L: 03 Hrs/week  | CIE: 20 Marks<br>ISE: 20 Marks<br>ESE: 60 Marks |
| Prerequisite: Students should have prior knowledge of                                                                                                                                                                                                                                                                                                                                                                                                                     |                                            |                 |                                                 |
| <ul style="list-style-type: none"><li>Operating Systems (OS)</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                    |                                            |                 |                                                 |
| Course Objectives: The objective of this course is to provide students with                                                                                                                                                                                                                                                                                                                                                                                               |                                            |                 |                                                 |
| <ul style="list-style-type: none"><li>Embedded operating systems fundamentals.</li><li>I/O communication and protocols used in the embedded systems.</li><li>Security mechanisms in embedded operating systems</li><li>Understanding of Embedded Linux utilities and Android's internal architecture for embedded systems.</li></ul>                                                                                                                                      |                                            |                 |                                                 |
| Course Outcomes: After completing this course, students will be able to:                                                                                                                                                                                                                                                                                                                                                                                                  |                                            |                 |                                                 |
| CO1: Illustrate Embedded OS and RTOS functionalities                                                                                                                                                                                                                                                                                                                                                                                                                      |                                            |                 |                                                 |
| CO2: Identify communication interfaces and security mechanisms in embedded systems.                                                                                                                                                                                                                                                                                                                                                                                       |                                            |                 |                                                 |
| CO3 : Choose utilities and tools of embedded Linux systems for embedded applications.                                                                                                                                                                                                                                                                                                                                                                                     |                                            |                 |                                                 |
| CO4: Discuss the system components and development environment of embedded Android systems.                                                                                                                                                                                                                                                                                                                                                                               |                                            |                 |                                                 |
| COURSE CONTENTS                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                            |                 |                                                 |
| Module I                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Fundamentals of Embedded Operating Systems |                 | 12 Hrs                                          |
| Definition and characteristics of embedded systems. General-Purpose OS and Real-Time OS , Embedded OS architecture, Embedded SOC. Real-Time Tasks , Task states and context switching, Scheduling, Inter-Process Communication (IPC) and Synchronization, Memory Management, Interrupt Handling, Device Drivers. Processors for embedded systems : ARM processors and its versions , ARM, ARM CORTEX series, RISC-V<br>Case Study: zephyr , FreeRTOS , TockOS and Hubris. |                                            |                 |                                                 |
| Module II                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | I/O Communications and Security            |                 | 09 Hrs                                          |
| Types of serial communication, Serial protocols, Parallel ports and interfacing, Parallel device protocols: ISA, PCI, PCI/X, ARM bus, Internet enabled systems-Network Protocol, Wireless and mobile system Protocols Embedded OS Security: Root of Trust (RoT) concepts, Secure Boot & Chain of Trust, Trusted Execution Environment (TEE), Sandboxing, Encryption in Embedded OS, Over-the-Air (OTA) Updates, Data protection protocols.                                |                                            |                 |                                                 |
| Module III                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Embedded Linux                             |                 | 09 Hrs                                          |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                         |               |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|---------------|
| Linux Kernel background, Anatomy of Embedded Systems, Embedded Linux Architecture, BIOS versus boot-loader, U-BOOT , Storage considerations & SPI Flash in Boot Flow, Kernel Boot Process, BusyBox, Embedded Linux Distribution, Embedded Development Environment, Cross Development Environment, Tool Chain, Tools Overview.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                         |               |
| <b>Module IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>Embedded Android</b> | <b>09 Hrs</b> |
| Introduction to Android for embedded Systems, Android Kernel & Device Tree, Native Android user-space, Android Boot Process : Bootloader, Init Process, Zygote Process, system_server Process, Role in Service Startup, Activity Manager Service (AMS), System Services, Android Recovery, Verified Boot, Android Customization, Debugging & Deployment : ADB (Android Debug Bridge)                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                         |               |
| <b>Text Books:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                         |               |
| <b>T1.</b> R. Kamal, <i>Embedded Systems: Architecture, Programming and Design</i> , 3rd ed. New York, NY, USA: McGraw-Hill, Jul. 2017. ISBN: 978-0078028240.<br><b>T2.</b> C. Hallinan, <i>Embedded Linux Primer: A Practical, Real-World Approach</i> , 2nd ed. Upper Saddle River, NJ, USA: Prentice Hall, Oct. 2010. ISBN: 978-0137017836.<br><b>T3.</b> K. Yaghmour, <i>Embedded Android: Porting, Extending, and Customizing</i> , 2nd ed. Sebastopol, CA, USA: O'Reilly Media, Apr. 2013. ISBN: 978-1-4919-2071-8.<br><b>T4.</b> D. Kleidermacher and M. Kleidermacher, <i>Embedded Systems Security</i> . Waltham, MA, USA: Elsevier, Mar. 2012. ISBN: 978-0128039298.                                                                                                                                                                                    |                         |               |
| <b>Reference Books:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                         |               |
| <b>R1.</b> L. B. Das, <i>Embedded Systems: An Integrated Approach</i> . New Delhi, India: Pearson Education, 2013. ISBN: 978-81-317-8766-3.<br><b>R2.</b> J. Yiu, <i>The Definitive Guide to the ARM® Cortex-M3</i> , 2nd ed. Amsterdam, Netherlands: Elsevier, Oct. 2007. ISBN-10: 0750685344; ISBN-13: 978-0750685344.<br><b>R3.</b> K. C. Wang, <i>Embedded and Real-Time Operating Systems</i> . Cham, Switzerland: Springer International Publishing, 2017. ISBN-13: 9783319515168.<br><b>R4.</b> R. Kamal, <i>Embedded Systems: Architecture, Programming and Design</i> , 2nd ed. New Delhi, India: McGraw-Hill, Jan. 2009. ISBN: 9780070151253.<br><b>R5.</b> W. Wolf, <i>Computers as Components: Principles of Embedded Computing System Design</i> , 2nd ed. Burlington, MA, USA: Morgan Kaufmann, 2008. ISBN-10: 0123743974; ISBN-13: 978-0123743978. |                         |               |
| <b>Relevant MOOCs Courses:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                         |               |
| 1. NPTEL on Real-Time Systems, IIT Kharagpur, NIT Rourkela By Prof. Rajib Mall, Prof. Durga Prasad Mohapatra, <a href="https://onlinecourses.nptel.ac.in/noc25_cs156/preview">https://onlinecourses.nptel.ac.in/noc25_cs156/preview</a><br>2. NPTEL on , Real-Time Operating Systems: By Prof. Rajib Mall , IIT Kharagpur <a href="https://onlinecourses.nptel.ac.in/noc25_cs78/preview">https://onlinecourses.nptel.ac.in/noc25_cs78/preview</a>                                                                                                                                                                                                                                                                                                                                                                                                                 |                         |               |
| <b>Relevant Topics for Self-study:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                         |               |
| 1. RISC-V Architecture<br>2. Embedded ML                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                         |               |

**Other Resources/Links:**

1. Ibex: <https://github.com/lowRISC/ibex>
2. TockOS : <https://tockos.org/>
3. Hubris : <https://www.trustedfirmware.org/>

PICT CETYPE 2026-27



| Third Year B. Tech (T. Y B. Tech) AY (2026-27)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                  |                 |                                                |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|-----------------|------------------------------------------------|
| Computer Engineering (CE)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                  |                 |                                                |
| [2616PE23]: Computer Vision (CV)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                  |                 |                                                |
| Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Credits                          | Teaching Scheme | Examination Scheme                             |
| 6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 3                                | L: 03 Hrs/week  | CIE: 20 Marks<br>ISE: 20 Marks<br>ESE: 60Marks |
| Prerequisite: Students should have prior knowledge of                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                  |                 |                                                |
| <ul style="list-style-type: none"><li>Python/MATLAB</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                  |                 |                                                |
| Course Objectives: The objective of this course is to provide students with                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                  |                 |                                                |
| <ul style="list-style-type: none"><li>Fundamental concepts and techniques of computer vision for real-world applications.</li><li>Concept of feature extraction, image segmentation, and 3D vision techniques for effective reconstruction and shape recovery.</li><li>Knowledge of object detection and tracking algorithms, including optical flow, deep learning models, and transfer learning techniques, for real-world vision tasks.</li><li>Analyze and Apply object recognition techniques and vision-based applications in domains such as traffic management, surveillance, and intelligent transportation systems.</li></ul> |                                  |                 |                                                |
| Course Outcomes: After completing this course, students will be able to:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                  |                 |                                                |
| CO1: Apply preprocessing, enhancement techniques for computer vision.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                  |                 |                                                |
| CO2: Identify and Apply feature extraction, segmentation, and 3D vision methods for reconstruction and depth estimation.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                  |                 |                                                |
| CO3: Analyze object detection and tracking algorithms using classical and deep learning approaches.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                  |                 |                                                |
| CO4: Apply object recognition techniques to real-world domains such as traffic and intelligent transportation systems.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                  |                 |                                                |
| COURSE CONTENTS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                  |                 |                                                |
| Module I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Introduction of Computer Vision  |                 | 12 Hrs                                         |
| Introduction: Definition and Scope of Computer Vision. Image Formation Process: Pinhole Camera Model, Perspective Projection matrices, Geometric Camera Calibration. Image Processing for Vision: Image Pre-processing: Resizing, Normalization, Histogram Equalization, Noise Models (Gaussian, Salt & Pepper, Speckle, photon noise) and Denoising, Filters (Mean, Median, Gaussian, Bilateral) Edge Detection: Sobel, Prewitt, Canny, Image Enhancement and Morphological Operations (Erosion, Dilation, Opening, Closing). Applications of Computer Vision: Robotics, Healthcare, Surveillance, Autonomous Vehicles, AR/VRR.        |                                  |                 |                                                |
| Module II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Feature Extraction and 3D Vision |                 | 9 Hrs                                          |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                  |              |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------|--------------|
| Feature Extraction: Key points and Descriptors: Harris Corner Detector, SIFT, SURF, ORB, Feature Matching: Brute Force Matcher, FLANN Hough Transform for Line and Circle Detection. Image Segmentation: Thresholding, Region Growing, Watershed, K-Means Clustering. Stereo Vision & Correspondence: The three-dimensional world, Methods for 3D vision, Stereo vision, Projection schemes for 3D vision, 3D Reconstruction, Stereo setups, Epipolar Geometry, correspondence algorithms. Shape from X:Shape from shading, structured light, depth from defocus                                                                                                            |                                                  |              |
| <b>Module III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>Object Detection and Tracking</b>             | <b>9 Hrs</b> |
| Optical Flow(Lucas-Kanade, Horn-Schunck), structure from motion (SfM). Object Detection and Tracking: classical object detection (Viola-Jones, HOG+SVM, R-CNN, YOLO, SSD). OBJECT TRACKING classical algorithm (Mean-Shift/CAM Shift, particle filters/Kalman Filter), Multi-object tracking (SORT, Deep SORT) Transfer Learning and Pre-trained Models (VGG, ResNet, EfficientNet)                                                                                                                                                                                                                                                                                         |                                                  |              |
| <b>Module IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>Object Recognition and Vision application</b> | <b>9 Hrs</b> |
| Object Recognition: Object representation and feature matching, Object centered representation, viewer Centre representation, Matching: pose clustering, geometric hashing, Interpretation trees, Registration and distance transform. Application: Traffic management system – The basic geometry, foreground-background separation, particle filters, Chamfer Matching, Tracking, and Occlusion, combining views from multiple cameras, License Plate Location, Occlusion Classification for Tracking, Human Gait Analysis, In-vehicle vision system:Locating the Roadway, Location of Road Markings, Location of Road Signs, Location of Vehicles, Locating Pedestrians. |                                                  |              |
| <b>Tools :</b> TensorFlow / Keras / PyTorch,OpenCV, Scikit-Image,OpenCV, NumPy, Matplotlib                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                  |              |
| <b>Text Books:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                  |              |
| <b>T1.</b> D. A. Forsyth and J. Ponce, <i>Computer Vision: A Modern Approach</i> , 2nd ed. Upper Saddle River, NJ, USA: Pearson, 2011. ISBN: 978-9332550117.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                  |              |
| <b>T2.</b> R. Szeliski, <i>Computer Vision: Algorithms and Applications</i> . London, U.K.: Springer, 2010. ISBN-13: 978-1848829343.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                  |              |
| <b>Reference Books:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                  |              |
| <b>R1.</b> M. Bennamoun and G. J. Mamic, <i>Object Recognition: Fundamentals and Case Studies</i> . London, U.K.: Springer, 2002. ISBN-10: 1447137248; ISBN-13: 978-1447137245.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                  |              |
| <b>R2.</b> R. Hartley and A. Zisserman, <i>Multiple View Geometry in Computer Vision</i> , 2nd ed. Cambridge, U.K.: Cambridge University Press, 2004. ISBN-10: 0521540518; ISBN-13: 978-0521540513.                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                  |              |
| <b>R3.</b> D. A. Forsyth and J. Ponce, <i>Computer Vision: A Modern Approach</i> , 2nd ed. Upper Saddle River, NJ, USA: Pearson, 2011. ISBN: 013300192X; 9780133001921.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                  |              |
| <b>R4.</b> J. E. Solem, <i>Programming Computer Vision with Python</i> . Sebastopol, CA, USA: O'Reilly Media, Jul. 2012. ISBN-10: 1449316549; ISBN-13: 978-1449316549.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                  |              |
| <b>Relevant MOOCs Courses:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                  |              |
| 1. Computer Vision By Prof. Jayanta Mukhopadhyay IIT Kharagpur<br><a href="https://onlinecourses.nptel.ac.in/noc21_cs101/preview">https://onlinecourses.nptel.ac.in/noc21_cs101/preview</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                  |              |
| 2. Computer Vision And Image Processing - Fundamentals And Applications By Prof. M. K. Bhuyan IIT Guwahati <a href="https://onlinecourses.nptel.ac.in/noc25_ee13/preview">https://onlinecourses.nptel.ac.in/noc25_ee13/preview</a>                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                  |              |
| <b>Relevant Topics for Self-study:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                  |              |
| OpenCV and Python Imaging Library (PIL), Open GL and AR -Placing virtual object in the Image, Use optical flow to build a simple gesture recognition system.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                  |              |



| Third Year B. Tech (T. Y B. Tech) AY (2026-27)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                           |                 |                                                 |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------|-----------------|-------------------------------------------------|
| Computer Engineering (CE)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                           |                 |                                                 |
| [2616PE24]: Server Side Technologies (SST)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                           |                 |                                                 |
| Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Credits                                   | Teaching Scheme | Examination Scheme                              |
| 6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 3                                         | L: 03 Hrs/week  | CIE: 20 Marks<br>ISE: 20 Marks<br>ESE: 60 Marks |
| <b>Pre-requisite: Students should have prior knowledge of</b> <ul style="list-style-type: none"><li>Client-side Technologies &amp; Frameworks</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                           |                 |                                                 |
| <b>Course Objectives: The objective of this course is to provide students with</b> <ul style="list-style-type: none"><li>Fundamentals of server side programming.</li><li>Configuration of servers and use of Web services.</li><li>Basics of Java Servlets and JSP for server side development.</li><li>Use Node.js with Express.js in server side applications.</li></ul>                                                                                                                                                                                                                                                     |                                           |                 |                                                 |
| <b>Course Outcomes: After completing this course, students will be able to:</b><br><b>CO1: Illustrate</b> the architectures and framework for server side programming.<br><b>CO2: Configuration</b> of application server for web application.<br><b>CO3: Design</b> server side application by using Java Servlet and JSP functionalities.<br><b>CO4: Design</b> server side applications demonstrating use of Node.js with Express.js                                                                                                                                                                                         |                                           |                 |                                                 |
| COURSE CONTENTS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                           |                 |                                                 |
| Module I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Fundamentals of Server-Side Technologies  |                 | 12 Hrs                                          |
| Introduction to Web Architecture: Client-Server architecture model and communication, Request/Response cycle, web and application servers, HTTP and HTTPS protocols, HTTP methods, GET, PUT, POST, DELETE, status codes. Architecture and frameworks: APIs, MVC and MVVM architectural patterns in frameworks, RESTful design principles, overview of request handling in RESTful API, data exchange using JSON. Security Fundamentals: Input validation and sanitization, Cross-site scripting (XSS), SQL injection, Authentication (sessions, cookies, JWT), HTTPS, SSL/TLS, best practices for securing server applications. |                                           |                 |                                                 |
| Module II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Web, Application Servers and Web Services |                 | 9 Hrs                                           |
| <b>Introduction to Application Servers</b> , Difference between Web Server and Application Server, Middleware concept, Business logic layer, Popular Application servers Apache tomcat, JBOSS, Glassfish, Microservices deployment overview<br><b>Server Configuration &amp; Management:</b> Virtual Hosting, Name-based virtual hosting, IP-based hosting Multi-site configuration, Security Configuration, SSL/TLS setup, HTTPS configuration,<br><b>Web Services:</b> Need for Web Services, SOA, RESTful Web Services, REST principles (Statelessness, Resource-based architecture), URI design, Status codes,              |                                           |                 |                                                 |

**SOAP web services:** Simple Object Access Protocol (SOAP), XML-based messaging, WSDL (Web Services Description Language), UDDI.

**Case Study: Configuration of apache-tomcat application server and application**

| Module III | Java Servlet and JSP | 9 Hrs |
|------------|----------------------|-------|
|------------|----------------------|-------|

Servlet: Servlet architecture overview, Servlet life cycle, setting up Servlet development environment, request and response handling in Servlets, Servlets generating dynamic content, parameter data, sessions tracking methods, session management, Servlets concurrency, Servlet and database connectivity. JSP: Java Server Pages life cycle, support for the Model-View-Controller paradigm, JSP vs Servlets, running JSP applications, JSP tags, JSP implicit objects, JSP and database connectivity, JavaBeans classes and JSP, JSTL (Java Server Pages Standard Tag Library) and Expression Language (EL).

**Case study: public service portals that use Java Servlet and JSP.**

| Module IV | Server-side Rendering: Node.js with Express.js | 9 Hrs |
|-----------|------------------------------------------------|-------|
|-----------|------------------------------------------------|-------|

Node.js: Introduction to Node.js runtime environment, setting up the development environment for Node.js, event-driven and non-blocking I/O model, Node.js architecture: single-threaded event loop, node modules, npm packages, package.json and semantic versioning, core modules, simple HTTP server with Node.js core http module. Express.js: Introduction to the Express.js framework, setting up an Express application, use of Express middleware, Express routing, serving static files with Express, and REST API with Express.js.

Case study: Lenskart web application based on Node.js and Express.js.

**Text Books:**

**T1.** M. Hall, L. Brown, and Y. Chaikin, *Core Servlets and JavaServer Pages, Volume II: Advanced Technologies*, 2nd ed. Upper Saddle River, NJ, USA: Pearson Education, 2007. ISBN-13: 9780130092298.

**T2.** B. Kurniawan and P. Deck, *Servlet, JSP and Spring MVC*. San Francisco, CA, USA: Brainy Software Inc., 2015. ISBN-13: 9781771970273.

**T3.** J. C. Jackson, *Web Technologies: A Computer Science Perspective*, 2nd ed. Upper Saddle River, NJ, USA: Pearson Education, 2007. ISBN: 978-0131856035.

**T4.** R. W. Sebesta, *Programming the World Wide Web*, 4th ed. Boston, MA, USA: Pearson Education, 2008.

**T5.** A. Mead, *Learning Node.js Development*. Birmingham, U.K.: Packt Publishing, 2018. ISBN: 9781788395540.

**Reference Books:**

**R1.** Marty Hall, Larry Brown, "Core Web Programming", 2001, Second Edition, Pearson Education, ISBN- 978-0130897930.

**R2.** Ethan Brown, "Web Development with Node and Express", 2019, Second Edition, O'Reilly Publication, ISBN-10:1492053511, ISBN-13:978-1492053514

**R3.** H.M. Deitel, P.J. Deitel and A.B. Goldberg, "Internet & World Wide Web How To Program", Third Edition, Pearson Education, 2006, ISBN 978-0131752429.

**R4.** Chris Bates, "Web Programming Building Internet Applications", 3rd Edition, Wiley India, 2006.

**Relevant MOOCs Courses:**

1. Web Technology By Dr. Ashutosh Kumar Bhatt- Uttarakhand Open University, Haldwani  
[https://onlinecourses.swayam2.ac.in/nou24\\_cs09/preview](https://onlinecourses.swayam2.ac.in/nou24_cs09/preview)
2. Modern Application Development By Prof. Aamod Sane, Prof. Abhijat Vichare, Prof. Madhavan Mukund-Persistent Computing Institute, Chennai Mathematical Institute  
[https://onlinecourses.nptel.ac.in/noc20\\_cs52/preview](https://onlinecourses.nptel.ac.in/noc20_cs52/preview)

**Relevant topics for Self study:**

Fundamentals of computer networks, protocols, Core Java Programming, JSON & XML, Fundamentals of APIs, Linux basics (commands, file system), Appl Environment variables, Logging & monitoring.

**Other Resources/Links:**

1. <https://www.ibm.com/docs/en/i/7.4.0?topic=java-jsp-servlet-programming>



| Third Year B. Tech (T. Y B. Tech) AY (2026-27)                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                               |                 |                                                 |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------|-----------------|-------------------------------------------------|
| Computer Engineering (CE)                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                               |                 |                                                 |
| [2616PE25]: Data Privacy and Ethics (DPE)                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                               |                 |                                                 |
| Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Credits                                       | Teaching Scheme | Examination Scheme                              |
| 6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 3                                             | L: 03 Hrs/week  | CIE: 20 Marks<br>ISE: 20 Marks<br>ESE: 60 Marks |
| <b>Prerequisite: Students should have prior knowledge of</b> <ul style="list-style-type: none"><li>Fundamentals Computer Networks and Information Security</li><li>Database Management Systems, Data Analytics or Big Data concepts</li></ul>                                                                                                                                                                                                                                                          |                                               |                 |                                                 |
| <b>Course Objectives: The objective of this course is to provide students with</b> <ul style="list-style-type: none"><li>Fundamental concepts of data privacy, protection, and ethical issues in digital systems.</li><li>Understanding of privacy-preserving technologies and data protection mechanisms.</li><li>The methods of analysing legal, social, and ethical implications of data usage and digital technologies.</li></ul> Knowledge to design responsible and ethical data-driven systems. |                                               |                 |                                                 |
| <b>Course Outcomes: After completing this course, students will be able to:</b><br><b>CO1:</b> Explain fundamental principles of data privacy and digital information ethics.<br><b>CO2:</b> Analyse privacy risks and threats in digital systems and data-driven applications.<br><b>CO3:</b> Evaluate privacy-preserving technologies and regulatory frameworks.<br><b>CO4:</b> Design a system to incorporate ethical principles (responsible data collection, processing, and sharing).            |                                               |                 |                                                 |
| COURSE CONTENTS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                               |                 |                                                 |
| Module I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Introduction to Data Privacy & Ethics         |                 | 12 Hrs                                          |
| Concept of data and personal data, Privacy vs security vs confidentiality, Evolution of data privacy and ethical computing, Ethical theories in information systems, Data lifecycle and data ownership, Overview of privacy threats, attacks, and vulnerabilities, Privacy risks in digital environments, Case studies on High-profile privacy breaches, privacy violations.                                                                                                                           |                                               |                 |                                                 |
| Module II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Privacy Models, Principles, and Architectures |                 | 9 Hrs                                           |
| Data lifecycle and privacy issues, Privacy principles: transparency, consent, purpose limitation, Privacy models: k-anonymity, differential privacy, Encryption and anonymization techniques, Privacy-preserving data mining, Privacy by design approach, Data anonymization and, pseudonymization techniques, Differential privacy, k-anonymity, l-diversity, t-closeness, Secure data lifecycle management.                                                                                          |                                               |                 |                                                 |
| Module III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Legal, Regulatory, and Policy Frameworks      |                 | 9 Hrs                                           |
| Overview of international laws: GDPR, CCPA, HIPAA, DPDPA, Cross-border data transfers and adequacy decisions, Role of Data Protection Officers (DPOs) and compliance audits, Ethical and legal considerations for AI and machine learning systems                                                                                                                                                                                                                                                      |                                               |                 |                                                 |
| Module IV                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Emerging Trends and Ethical Challenges        |                 | 9 Hrs                                           |

Ethical issues in AI and machine learning, Bias, fairness, and transparency in algorithms, Responsible data sharing and open data, Ethical challenges in social media, IoT, and big data, Surveillance, data monetization, and digital identity ethics, Building ethical organizations and responsible innovation Case studies: healthcare, finance, and smart cities, Future trends in data ethics and governance.

#### **Text Books:**

**T1.** 1. V. Torra, *Guide to Data Privacy: Models, Technologies, Solutions*. Cham, Switzerland: Springer, 2022. ISBN: 978-3-031-12836-3 (Print), 978-3-031-12837-0 (eBook).

**T2.** 1. S. Shukla, J. P. George, K. Tiwari, and J. V. Kureethara, *Data Ethics and Challenges*. Singapore: Springer, 2022. ISBN: 978-981-19-0751-7 (Print), 978-981-19-0752-4 (eBook).

**T3.** 1. H. J. Smith, T. Dinev, and H. Xu, *Information Privacy: Concepts, Theories, and Practices*. New York, NY, USA: Routledge, 2018. ISBN: 978-1138309777

**T4.** E. B. Mandinach and J. L. Abrams, *Data Ethics: How Educators Can Use Data Effectively and Responsibly*. London, U.K.: Bloomsbury Academic, 2021. ISBN: 978-1350176164

#### **Reference Books:**

**R1.** D. J. Solove and P. M. Schwartz, *Information Privacy Law*, 8th ed. New York, NY, USA: Aspen Publishing, 2023. ISBN: 979-8-8861-4335-5.

**R2.** M. J. Quinn, *Ethics for the Information Age*, 8th ed. Boston, MA, USA: Pearson, 2020. ISBN: 978-0136681595.

**R3.** T. P. Keenan, *Technocreep: The Surrender of Privacy and the Capitalization of Intimacy*. Berkeley, CA, USA: OR Books, 2014. ISBN: 978-1939293749

#### **Relevant MOOCs Courses:**

1. Cyber Security and Privacy – IIT Madras by Prof. Saji K. Mathew, Duration: 12 Weeks, Course Link: [Open NPTEL Course – Cyber Security and Privacy](#)

#### **Relevant topics for Self study:**

1. Differential Privacy in Machine Learning
2. Privacy-Preserving Data Mining Techniques
3. Federated Learning and Data Privacy
4. Ethical Issues in Artificial Intelligence

#### **Other Resources/Links:**

1. C. Dwork, "Differential privacy," in *Proc. 33rd Int. Colloquium on Automata, Languages and Programming (ICALP)*, Venice, Italy, 2006, pp. 1–12.
2. A. Narayanan and V. Shmatikov, "Robust de-anonymization of large sparse datasets," in *Proc. IEEE Symposium on Security and Privacy*, Oakland, CA, USA, 2008, pp. 111–125.
3. M. Barbaro and T. Zeller, "A face is exposed for AOL searcher no. 4417749," *The New York Times*, Aug. 2006.
4. S. Zuboff, "Big other: Surveillance capitalism and the prospects of an information civilization," *Journal of Information Technology*, vol. 30, no. 1, pp. 75–89, 2015
5. B. Goodman and S. Flaxman, "European Union regulations on algorithmic decision-making and a 'right to explanation'," *AI Magazine*, vol. 38, no. 3, pp. 50–57, 2017.



**Third Year B. Tech (T. Y B. Tech) AY (2026-27)**  
**Computer Engineering (CE)**  
**[2616PE31]: Program Elective-II and III Lab**

| Semester | Credits | Teaching Scheme | Examination Scheme                     |
|----------|---------|-----------------|----------------------------------------|
| 6        | 2       | P: 04 Hrs/week  | CIE(TW): 50 Marks<br>ESE(PR): 50 Marks |

**Program Elective-II Lab**

**Machine Learning Lab (ML)**

**Course Objectives: The objective of this course is to provide students with**

- Understand fundamental concepts of Machine Learning and its real-world applications.
- Apply data preprocessing and exploratory data analysis techniques to prepare datasets for modeling.
- Develop Machine Learning models using appropriate algorithms for classification, regression, and pattern discovery.
- Evaluate and interpret model performance using suitable metrics to draw conclusions and improve solutions.

**Course Outcomes: After completing this course, students will be able to:**

**C01: Perform** data preprocessing and exploratory data analysis to prepare datasets for effective Machine Learning model development.

**C02: Apply** Machine Learning algorithms for building classification and regression models

**C03: Evaluate** machine learning algorithm performance.

**List of Assignments**

| Expt.No. | Problem Statement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | CO's              |
|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| 1.       | Download BMI dataset from Kaggle<br><a href="https://www.kaggle.com/datasets/yasserh/bmidataset">https://www.kaggle.com/datasets/yasserh/bmidataset</a><br>For the large dataset(BMI dataset) compute the covariance matrix, find eigen values and identify the principle component and obtain the new low dimensional representation of data.                                                                                                                                                   | C01<br>C02        |
| 2.       | Download Email spam classification dataset from Kaggle<br><a href="https://www.kaggle.com/datasets/balaka18/email-spam-classification-dataset-csv">https://www.kaggle.com/datasets/balaka18/email-spam-classification-dataset-csv</a><br>Email Spam detection has two states: a) Normal State – Not Spam, b) Abnormal State– Spam. Use K-Nearest Neighbors and Support Vector Machine to classify the Email. Extract confusion matrix from the test results and compare the performance of both. | C01<br>C02<br>C03 |

|    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                 |
|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|
|    | <p style="text-align: center;"><b>OR</b></p> <p>Download Housing Rent Prediction Dataset from Kaggle and predict the house rent using regression.<br/> <a href="https://www.kaggle.com/datasets/iamsouravbanerjee/house-rent-prediction-dataset">https://www.kaggle.com/datasets/iamsouravbanerjee/house-rent-prediction-dataset</a></p>                                                                                                                                                                                                                                                                                                               |                                                 |
| 3. | <p>Download the fashion MNIST dataset from kaggle for Classification<br/> <a href="https://www.kaggle.com/datasets/zalando-research/fashionmnist">https://www.kaggle.com/datasets/zalando-research/fashionmnist</a><br/>           Build a simple feedforward neural network to classify Fashion-MNIST images (shirts, shoes, trousers, bags, etc.). Compare performance with logistic regression. Report accuracy, precision, recall, F1-score.</p> <p style="text-align: center;"><b>OR</b></p> <p>Download Market Basket Analysis Dataset from Kaggle and implement the Apriori algorithm. Compute support, confidence, and lift for each rule.</p> | <p><b>C01</b><br/><b>C02</b><br/><b>C03</b></p> |
| 4. | <p>Download student performance dataset from kaggle for Predicting Student Academic Performance using Ensemble Learning and Model Explainability Techniques<br/> <a href="https://www.kaggle.com/datasets/rabieelkharoua/students-performance-dataset">https://www.kaggle.com/datasets/rabieelkharoua/students-performance-dataset</a><br/>           Apply XGBoost and other ensemble learning models to predict student grades. Compare the performance of various ensemble models. Identify key factors influencing student academic outcomes.</p>                                                                                                  | <p><b>C01</b><br/><b>C02</b><br/><b>C03</b></p> |
| 5. | <p>Mini Project<br/>           Students are supposed to select a real-world problem and develop a Machine Learning-based solution using an appropriate dataset.<br/>           The mini project should specify</p> <ol style="list-style-type: none"> <li>Problem definition, data collection and preprocessing, exploratory data analysis, model development using suitable algorithms.</li> <li>Performance evaluation needs to be performed using standard metrics.</li> <li>Analyze and explain the model results to draw useful conclusions and recommend possible enhancements or future improvements.</li> </ol>                                | <p><b>C01</b><br/><b>C02</b><br/><b>C03</b></p> |

### Big Data Analytics Lab (BDAL)

**Course Objectives: The objective of this course is to provide students with**

- Explore big data frameworks for predictive and real time data analytics

**Course Outcomes: After completing this course, students will be able to:**

**C01. Apply** ML algorithms in real life problems.

**C02. Design** predictive models and real-time data analytics using big data frameworks

### Assignment List

| EXPT. NO | Problem Statement                                                                                                                                          | CO's       |
|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| 1.       | Perform data preprocessing and statistical analysis on a suitable dataset to demonstrate measures of central tendency, dispersion, and hypothesis testing. | <b>C01</b> |

|    |                                                                                                                                                                                                                                                  |            |
|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| 2. | Implement a classification algorithm on a suitable dataset with preprocessing and evaluate model performance using a confusion matrix and related metrics.                                                                                       | C01        |
| 3. | Implement Simple Naïve Bayes classification algorithm using Python/R on a suitable dataset. Apply suitable Preprocessing methods. Compute Confusion matrix to find TP, FP, TN, FN, Accuracy, Error rate, Precision, Recall on the given dataset. | C01        |
| 4. | Use Apache Spark to analyze a suitable dataset by applying RDD operations, MLlib algorithms, and Spark Streaming for real-time data processing.                                                                                                  | C02        |
| 5. | <b>Mini Project</b> :Install and configure Hadoop, and perform predictive analytics using MapReduce along with data analysis using Hive and Pig on a suitable dataset.                                                                           | C01<br>C02 |

### Human Computer Interaction (HCIL)

**Course Objectives: The objective of this course is to provide students with**

1. Understand the fundamental concepts and principles of Human-Computer Interaction for designing user-friendly systems.
2. Analyze user requirements using user research techniques such as surveys and persona creation. Design and develop low-fidelity and high-fidelity prototypes using UI/UX design tools.
3. Evaluate and improve interface usability using usability testing methods and design principles.

**Course Outcomes: After completing this course, students will be able to:**

**C01:** Evaluate applications using usability principles such as Jakob Nielsen's heuristics and Ben Shneiderman's golden rules.

**C02:** Perform user analysis through surveys and create personas and user scenarios.

**C03:** Develop low-fidelity and high-fidelity prototypes using UI/UX tools.

**C04:** Conduct usability testing and redesign interfaces using principles such as Paul Fitts' law to improve usability and efficiency.

### Assignment List

| Expt.No | Problem Statement                                                                                                                                                                                                                                   | CO's |
|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| 1.      | Select a popular application (e.g., WhatsApp, Amazon, College ERP, etc.).Evaluate it using:<br>a)Nielsen's 10 Usability Heuristics<br>b)Shneiderman's 8 Golden Rules<br>c)Identify usability problems.<br>Suggest improvements with mock redesigns. | C01  |
| 2.      | <u>Persona Creation and User Analysis:</u><br>Choose a system (e.g., Online Food Ordering System).Conduct a small survey (5-10 users).<br>Create: a)User personas (at least 2)                                                                      | C02  |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | b)User scenarios                                                                                                                                                                                                                        |                                 |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|
| 3.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <u>Low-Fidelity &amp; High-Fidelity Prototyping:</u><br>Select an application idea (e.g., Library Management App).<br>Create:a).Paper prototype (Low-fidelity)<br>b).Digital prototype (Figma / Adobe XD)                               | C02<br>C03                      |
| 4.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <u>Usability Testing:</u><br>Test the prototype from Assignment 3.<br>Recruit 5 users and perform:<br>a).Task-based testing<br>b).Think-aloud protocol<br>Measure :-Task completion time,Error rate, User satisfaction (Likert scale)   | C02<br>C03<br>C04               |
| 5.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Mini Projects<br>a)Redesign of Government Service Website for Better Usability<br><b>OR</b><br>b) Fitts' Law Based Interface Efficiency Study:analyze how button size and distance affect task completion time in graphical interfaces. | C01<br>C02<br>C03<br>C04<br>C04 |
| <b>261604142: Software Defined Networks (SDNL)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                         |                                 |
| <b>Course Objectives: The objective of this course is to provide students with</b> <ul style="list-style-type: none"> <li>Learn and Setup virtual environments for software defined networks.</li> <li>To impart knowledge on the core concepts, architecture and need for SDN.</li> <li>To understand Network Function Virtualization (NFV) and network virtualization techniques.</li> <li>To gain hands-on experience with emulation tools like Mininet for creating network topologies.</li> </ul> |                                                                                                                                                                                                                                         |                                 |
| <b>Course Outcomes: After completing this course, students will be able to:</b><br><b>C01:</b> Identify & apply the suitable tools available for constructing a SDN.<br><b>C02:</b> Design and set up virtual software defined networks.<br><b>C03:</b> Ability to implement SDN controllers to manage network traffic.<br><b>C04:</b> Ability to develop SDN applications for network monitoring or security.                                                                                         |                                                                                                                                                                                                                                         |                                 |
| <b>Assignment List</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                         |                                 |
| Expt.No.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Problem Statement                                                                                                                                                                                                                       | CO's                            |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | To Setup your own virtual SDN lab using one of the three options: Virtualbox/Mininet, Kathara, or GNS3                                                                                                                                  | C01                             |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | To Setup your own virtual SDN lab using one of the three options: Virtualbox/Mininet, Kathara, or GNS3                                                                                                                                  | C01                             |

|    |                                                                                                                                                                                                                                       |     |
|----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| 3. | Prepare setup for Mininet network emulation environment with the help of Virtualbox and Mininet. Demonstrate the basic commands in Mininet and emulate different custom network topology (Simple, Linear, and Tree).View flow tables. | C02 |
| 4. | After studying open source POX and Floodlight controller, Install controller and run custom topology using remote controller like POX and floodlight controller. Recognize inserted flows by controllers.                             | C03 |
| 5. | Create a SDN environment on Mininet and configure a switch to provide a firewall functionality using POX controller.                                                                                                                  | C02 |
| 6. | <b>Mini Project:</b><br><br>Analyze various network protocol performances with number of nodes & provide experimental results by graph tool in NS3 simulation with network security parameters.                                       | C04 |

### Cyber Security (CSL)

**Course Objectives: The objective of this course is to provide students with**

- Explore the security aspect and ethics.

**Course Outcomes: After completing this course, students will be able to:**

**C01:** Design & implement program to analyze e-mail headers & investigate e-mail related cybercrimes

**C02:** Configure & simulate IEEE 802.11 wireless networks & detect unauthorized access attempts

**C03:** Investigate & propose solutions for cyber security threats by conducting survey on social engineering attacks

**C04:** Perform network & web application vulnerability assessments & demonstrate security solutions based on machine learning

### Assignment List

| Expt.No. | Problem Statement                                                                                                                                                                                                                                                                                      | CO's |
|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| 1        | Write a program for Tracking Emails & Investigating Email Crimes.                                                                                                                                                                                                                                      | C01  |
| 2        | A person on a nearby road is trying to enter into a WiFi network by trying to crack the Password to use the IP Printer resource; write a program to detect such an attempt and prohibit the access. Develop the necessary scenario by Using an IEEE 802.11, configure a Wi-Fi adapter and Access Point | C02  |
| 3        | Prepare a survey-based report on social engineering attacks such as phishing, baiting, or pretexting. Analyze user awareness levels and propose precautionary measures. Research and prepare a paper on the role of Artificial Intelligence and IoT in                                                 | C03  |

|   |                                                                                                                                                                                                                                                                                                                                                                                                                     |     |
|---|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
|   | cybersecurity. Discuss potential threats, case studies of AI-driven attacks, and emerging defense techniques                                                                                                                                                                                                                                                                                                        |     |
| 4 | Perform a vulnerability scan of a given network or web application using tools such as Nmap, Wireshark, or OWASP ZAP. Document the identified vulnerabilities and recommend mitigation strategies.                                                                                                                                                                                                                  | CO4 |
| 5 | Mini-project: Develop machine learning based IDS / Secure password generator based on secure pseudo-random number generator / Secure your words before you send: The Kryptboard pre-send encryption method / honeypot / snort vulnerabilities / Simulate Wi-Fi networks using WEP, WPA, and WPA2 protocols. Demonstrate the weaknesses of older protocols and recommend practices to secure wireless communication. | CO4 |

### Program Elective-III Lab

#### Natural Language Processing (NLPL)

**Course Objectives: The objective of this course is to provide students with**

- To learn fundamental concepts of Natural Language Processing and enable students to perform text preprocessing techniques such as tokenization, stop-word removal, stemming, and lemmatization for preparing textual data.
- To develop the ability to implement word embedding techniques and understand numerical representation of text for language modeling and semantic analysis.
- To enable students to apply advanced NLP techniques such as Part-of-Speech (POS) tagging and Named Entity Recognition (NER) for extracting meaningful information from textual data.
- To equip students with the knowledge to design and develop Retrieval-Augmented Generation (RAG) systems for domain-specific applications.

**Course Outcomes: After completing this course, students will be able to:**

**CO1: Apply** text preprocessing techniques such as tokenization, stop-word removal, stemming, and lemmatization to prepare textual data for Natural Language Processing tasks.

**CO2: Implement** and analyze word embedding techniques to represent textual data in numerical form for effective language modeling and semantic analysis.

**CO3: Apply** advanced NLP methods including Part-of-Speech (POS) tagging and Named Entity Recognition (NER) to extract linguistic and contextual information from text for different applications.

**CO4: Design** RAG system for domain specific application.

#### Assignment List

| Expt.No. | Problem Statement | CO's |
|----------|-------------------|------|
|----------|-------------------|------|

|   |                                                                                                                                                                                                                                                                                                                                                                                                          |            |
|---|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| 1 | Apply text preprocessing and create embedding and evaluate.<br>Download a small text corpus e.g. nltk.corpus.movie_reviews dataset .                                                                                                                                                                                                                                                                     | C01<br>C02 |
| 2 | Implement a POS tagger using the Conditional Random Fields (CRF) algorithm. Ensure the model is trained, tested, and evaluated on labeled text data. Use the dataset: <a href="https://huggingface.co/datasets/batterdata/pos_tagging">https://huggingface.co/datasets/batterdata/pos_tagging</a>                                                                                                        | C03        |
| 3 | Perform name entity recognition, coreference resolution and analyze the performance. Evaluate both tasks using benchmark datasets (like CoNLL-2003 for NER or OntoNotes 5.0 for coreference) and measure performance with metrics such as precision, recall, and F1-score for NER, and MUC, B <sup>3</sup> , or CEAF scores for coreference resolution.                                                  | C03        |
| 4 | Implement a custom RAG system that retrieves and summarizes medical knowledge from trusted sources for clinicians. Use the PubMed Central Open Access dataset ( <a href="https://www.ncbi.nlm.nih.gov/pmc/tools/openftlist/">https://www.ncbi.nlm.nih.gov/pmc/tools/openftlist/</a> ) to index biomedical research papers. Combine retrieved context with an LLM to provide evidence-based answers.      | C04        |
| 5 | Mini project: Perform Hindi to English translation using a Transformer-based neural machine translation model. Use the Hindi-English parallel corpus from IIT Bombay available at <a href="https://www.cfilt.iitb.ac.in/iitb_parallel/">https://www.cfilt.iitb.ac.in/iitb_parallel/</a> . Train the model on the dataset and evaluate its performance using BLEU scores to measure translation accuracy. | C01<br>C02 |

### Embedded Operating System (EOSL)

**Course Objectives: The objective of this course is to provide students with**

- Design simple embedded applications to demonstrate the working of operating system services in embedded platforms.
- To gain practical exposure to embedded operating system environments.
- To demonstrate knowledge of embedded operating system concepts.

**Course Outcomes: After completing this course, students will be able to:**

C01 : **Implement** real-time operating system facilities.

C02 : **Implement** embedded operating system components.

C03 : **Develop** embedded system solutions for societal needs.

### Assignment List

| Expt No. | Problem Statement                                                          | CO's |
|----------|----------------------------------------------------------------------------|------|
| 1        | Implement multitasking in RTOS-based embedded systems.                     | C01  |
| 2        | Write simple applications using embedded Linux on the ARM platform.        | C02  |
| 3        | Write a Linux device Driver. Demonstrate loading and unloading from Kernel | C02  |
| 4        | Trace the Android boot process on an emulator or embedded device           | C02  |

| 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Mini Project : Develop Embedded Linux or Android System-Based Application for any real world application.                                                                                                                                                                                                                                                                                                                             | C03        |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>Computer Vision (CVL)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                       |            |
| <b>Course Objectives: The objective of this course is to provide students with</b> <ul style="list-style-type: none"> <li>To Understand Fundamental concepts and techniques of computer vision for real-world applications.</li> <li>To gain Knowledge of feature extraction, image segmentation, and 3D vision techniques for effective reconstruction and shape recovery.</li> <li>To analyze and apply Methods of object detection and tracking algorithms and various object recognition techniques.</li> </ul> |                                                                                                                                                                                                                                                                                                                                                                                                                                       |            |
| <b>Course Outcomes: After completing this course, students will be able to:</b><br><b>C01: Apply</b> preprocessing, enhancement techniques for computer vision.<br><b>C02: Identify and Apply</b> feature extraction, segmentation, and 3D vision methods for reconstruction and depth estimation<br><b>C03: Analyze</b> different object detection and tracking algorithms using classical and deep learning approaches.<br><b>C04: Apply</b> object recognition techniques to real-world domains.                 |                                                                                                                                                                                                                                                                                                                                                                                                                                       |            |
| <b>Assignment List</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                       |            |
| Expt.No.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Problem Statement                                                                                                                                                                                                                                                                                                                                                                                                                     | CO's       |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Implement and Analyse Harris, SIFT, SURF, ORB, and HOG techniques on the INRIA Person Dataset ( <a href="http://pascal.inrialpes.fr/data/human/">http://pascal.inrialpes.fr/data/human/</a> ) to detect and match pedestrians for autonomous driving applications, and analyze their robustness, accuracy, and execution time.                                                                                                        | C01        |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Build a feature detection and matching system using SIFT, ORB, and SURF on the Oxford Buildings Dataset. ( <a href="https://www.robots.ox.ac.uk/~vgg/data/oxbuildings/">https://www.robots.ox.ac.uk/~vgg/data/oxbuildings/</a> ) Test how well these methods can match the same building from different views, and compare their performance in terms of speed, accuracy, and robustness to changes in scale, rotation, and lighting. | C02        |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Implement a real-time hand gesture tracking system using any two object tracking algorithms (e.g., Mean-Shift, CAMShift, or KCF). Use video input (your own webcam or Hand Gesture Dataset) and compare the performance of the tracking algorithms in terms of accuracy, speed, and robustness. ( <a href="https://www.kaggle.com/datasets/gti-upm/leapgestrecog">https://www.kaggle.com/datasets/gti-upm/leapgestrecog</a> )         | C03        |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Implement a face recognition system using a pre-trained deep learning model (e.g., OpenFace, FaceNet, or a pre-trained CNN) and continuously track recognized faces in a video stream. Display bounding boxes with names over detected faces, simulating real-time applications like attendance or security systems.                                                                                                                  | C04        |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Create a real-time <b>mini-project</b> that recognizes a brand logo (e.g., Apple, Nike) in video frames using feature matching (e.g., SIFT or ORB) and then tracks the logo as it moves using a visual tracking algorithm (e.g., KCF, MOSSE). Demonstrate the application for interactive advertising or AR marketing.                                                                                                                | C03<br>C04 |

## Server Side Technologies (SST)

### Course Objectives: The objective of this course is to provide students with

- To Understand server-side web technologies and application server configuration for developing dynamic web applications.
- To Design and implement web applications using Java Servlets, JSP, and database connectivity.
- To develop skills for building interactive web applications using modern frameworks such as Node.js and Express.js.
- To apply server-side frameworks like Spring Boot, Hibernate, or Django to design and deploy real-world web applications.

### Course Outcomes: After completing this course, students will be able to:

**CO1:** Configure application servers and deploy basic server-side programs such as HTTP Servlets.

**CO2:** Design and implement database-driven web applications using Servlets, JSP, and MySQL with CRUD operations.

**CO3:** Develop interactive web applications using Node.js and Express.js for task or data management systems.

**CO4:** Build and deploy complete web-based applications using modern frameworks such as Spring Boot, Hibernate, or Django.

### Assignment List

| Expt.No. | Problem Statement                                                                                                                                                                          | CO's |
|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| 1        | Configure the Apache-tomcat application server and deploy the HTTP servlet which will display "helloworld".                                                                                | CO1  |
| 2        | Design and develop a student registration system for an event using Java Servlet that allows students to register for listed events. Perform CRUD operation with MySQL database.           | CO2  |
| 3        | Design and develop an online feedback management system using JSP that collects feedback on customizable criteria and shows the average score of each criteria to the concerned end-users. | CO2  |
| 4        | Design and develop a To-Do list application using Node.js with Express.js that allows users to add tasks, mark them as completed and delete tasks.                                         | CO3  |
| 5        | Mini project based on Springboot/ Hibernate/ Django.                                                                                                                                       | CO4  |

### Data Privacy and Ethics (DPEL)

### Course Objectives: The objective of this course is to provide students with

- Understanding of the fundamental concepts of data privacy and information ethics through analysis of real-world cases and privacy challenges in digital systems.
- Knowledge to identify and analyze privacy risks and threats in applications such as social media, e-commerce platforms, and data-driven services.
- Methods to explore privacy-preserving techniques such as anonymization, encryption, and differential privacy for protecting sensitive data.

- Knowledge to apply ethical principles and legal guidelines in designing privacy-aware systems and responsible data handling practices.

**Course Outcomes: After completing this course, students will be able to:**

**C01:** Explain fundamental concepts of data privacy, personal data protection, and information ethics.

**C02:** Analyze privacy threats, risks, and vulnerabilities in digital platforms and data-driven systems.

**C03:** Evaluate privacy-preserving technologies and legal frameworks such as anonymization, encryption, and data protection laws.

**C04:** Apply ethical principles and privacy-by-design approaches to develop responsible data-driven solutions.

**Assignment List**

| Expt.No. | Problem Statement                                                                                                                                                                                                                                                                                                                                                                                           | CO's                     |
|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
| 1.       | Analyse and define Privacy Policy for an organization.                                                                                                                                                                                                                                                                                                                                                      | C01                      |
| 2.       | Demonstration of Data Anonymization (Masking, Suppression and Generalization)                                                                                                                                                                                                                                                                                                                               | C03                      |
| 3.       | Analyze privacy risks in an online service (social media, banking, or e-commerce). Identify possible threats (Data leakage, Unauthorized access and Tracking and profiling)                                                                                                                                                                                                                                 | C02                      |
| 4.       | Understand ethical implications of data usage in technology. Select a system (Facial recognition, AI-based recruitment systems or Healthcare data analytics) and Analyze the system for Privacy issues, Bias and fairness and Transparency and accountability.                                                                                                                                              | C04                      |
| 5.       | Develop a privacy-aware solution or perform an in-depth analysis of data privacy issues. (Any one) <ol style="list-style-type: none"> <li>1. Design a privacy risk evaluation framework for mobile applications.</li> <li>2. Develop a simple anonymization tool for datasets using Python.</li> <li>3. Conduct a privacy audit of a public dataset and recommend privacy protection techniques.</li> </ol> | C01<br>C02<br>C03<br>C04 |



| 2606OE51: NPTEL / SWAYAM / MOOCs              |                    |                                           |
|-----------------------------------------------|--------------------|-------------------------------------------|
| <b>Teaching Scheme:</b><br>Online 2 Hrs/ Week | <b>Credits:</b> 02 | <b>Evaluation Scheme</b><br>ESE: 50 Marks |
| <b><u>Refer Annexure II</u></b>               |                    |                                           |



# Annexure-I

## Structure of Multi-Disciplinary Minor Courses

The structure for the multidisciplinary Minor courses is as follows.

|     |             |                                     | Teaching Scheme<br>(Hours/Week) |   |   |       | Credits |   |   |       | Examination Scheme and Marks |      |      |           |      |      |       |
|-----|-------------|-------------------------------------|---------------------------------|---|---|-------|---------|---|---|-------|------------------------------|------|------|-----------|------|------|-------|
| Sem | Course code | Name of the Course<br>(Short forms) | L                               | P | T | Total | L       | P | T | Total | Theory                       |      |      | Practical |      |      | Total |
|     |             |                                     |                                 |   |   |       |         |   |   |       | CIE                          | ISE  | ESE  | CIE       | ESE  |      |       |
|     |             |                                     |                                 |   |   |       |         |   |   |       | [20]                         | [20] | [60] | TW        | (PR) | (OR) |       |
| 3   | 2603MD11    | MDM-1                               | 2                               | - | - | 2     | 2       | - | - | 2     | 20                           | 20   | 60   | -         | -    | -    | 100   |
| 3   | 2603MD51    | MDM-1 Tut                           | -                               | - | 1 | 1     | -       | - | 1 | 1     | -                            | -    | -    | 25        | -    | -    | 25    |
| 4   | 2604MD11    | MDM-2                               | 2                               | - | - | 2     | 2       | - | - | 2     | 20                           | 20   | 60   | -         | -    | -    | 100   |
| 4   | 2604MD31    | MDM-2 Lab                           | -                               | 2 | - | 2     | -       | 1 | - | 1     | -                            | -    | -    | 25        | -    | -    | 25    |
| 5   | 2605MD11    | MDM-3                               | 2                               | - | - | 2     | 2       | - | - | 2     | 20                           | 20   | 60   | -         | -    | -    | 100   |
| 5   | 2605MD31    | MDM-3 Lab                           | -                               | 2 | - | 2     | -       | 1 | - | 1     | -                            | -    | -    | 25        | -    | -    | 25    |
| 6   | 2606MD11    | MDM-4                               | 2                               | - | - | 2     | 2       | - | - | 2     | 20                           | 20   | 60   | -         | -    | -    | 100   |
| 6   | 2601MD31    | MDM-4 lab                           | -                               | 2 | - | 2     | -       | 1 | - | 1     | -                            | -    | -    | 25        | -    | -    | 25    |
| 8   | 2607MD11    | MDM-5                               | -                               | - | 2 | 2     | -       | - | 2 | 2     | -                            | -    | -    | 50        | -    | -    | 50    |
|     |             | Total                               | 8                               | 6 | 3 | 17    | 8       | 3 | 3 | 14    | 80                           | 80   | 240  | 150       | 0    | 0    | 550   |

**Note:** In course code X is basket number. #: is laboratory or tutorial as per course requirements.

1. Students are instructed to select one basket labeled as MD-1 to MD-9 based on applicable criteria in the last column of the table below.
2. Follow the registration process initiated by the institute/ department.
3. Once the course is registered, change of the basket/course in any of the further semesters is not allowed.
4. The total credits will be the same for all the courses except MDM-5.
5. Departments may conduct MDM-5 in virtual mode for the smooth conduction of internship for the full duration.

## List of Multi-Disciplinary Minor Domains

**Link for MDM Syllabus: [Detailed Syllabus](#)**

| Sr. No. | Multi-Disciplinary Minor Domains          | SY                                                         |                                                      | TY                                                                  |                                                                                                        | B-Tech                                             | Offered to students of BTech Program |
|---------|-------------------------------------------|------------------------------------------------------------|------------------------------------------------------|---------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|----------------------------------------------------|--------------------------------------|
|         |                                           | MDM-1                                                      | MDM-2                                                | MDM-3                                                               | MDM-4                                                                                                  | MDM-5                                              |                                      |
|         |                                           | Sem-III                                                    | Sem-IV                                               | Sem-V                                                               | Sem-VI                                                                                                 | Sem-VII/VIII                                       |                                      |
| MD1     | Smart and Sustainable Systems (SSS)       | Fundamentals of Smart and Sustainable Systems (FS&SS) Tut. | IoT for Smart and Sustainable Systems (ISSS) & Lab   | Data Analytics for Smart and Sustainable Systems (DASSS) & Lab      | Security for Smart and Sustainable Systems (SSS) & Smart and Sustainable Systems Development (SSD) Lab | Smart and Sustainable System (SSD) (MOOC)          | ALL                                  |
| MD2     | Financial Technology and Management (FTM) | Finance and Management (FM)                                | Fundamentals of Financial Engineering (FFE) & Tut    | Banking, Financial Services and Insurance (BFSI) & Tut              | Fundamentals of Stock Market (FSM) & Tut                                                               | Fintech: Foundations & Applications (FFA) & Tut    | ALL                                  |
| MD3     | 3D- Printing (3DP)                        | 3D- Printing (3DP)                                         | 3D modeling and Design (3MD) & Lab                   | Fundamentals of Additive Manufacturing (FAM) & Lab                  | 3D Printing Materials and Processes (3DPMP)                                                            | Industry 4.0 and Digital Manufacturing (IDM)       | ALL                                  |
| MD4     | Electric Vehicles (EV)                    | Electric Vehicles (EV)                                     | EV foundation – Principles and Concepts (EVPC) & Lab | Advanced Motor Technologies and Power Electronics for EV(AMT) & Lab | EV Powertrain Dynamics and Control System(PDC) Tut/Lab                                                 | Intelligent EV Systems: AI IoT and Automation(IEV) | ALL                                  |
| MD5     | Applied Mathematics for Engineering (AME) | Applied Mathematics for Engineering (AME)                  | Linear Algebra with Python & Lab                     | Statistical Techniques and Numerical Methods with R & Lab           | Fuzzy Logic and Graph Theory with Matlab/Python & Lab                                                  | Optimization Techniques & Lab                      | ALL                                  |
| MD6     | Software Development (SD)                 | Software Development (SD)                                  | Data Structures and Algorithms (DSA) & Lab           | Object Oriented Programming (OOP) & Lab                             | Database and Management Systems (DBMS) & Lab                                                           | Web Development (WD) & Lab                         | E&TCE                                |
| MD7     | Autonomous and Intelligent Systems (AIS)  | Autonomous and Intelligent Systems (AIS)                   | Digital Systems and Organization (DSO) & Lab         | Smart System Engineering (SSE) & Lab                                | Embedded IoT Systems (EIS) & Lab                                                                       | Autonomous Systems (AS) & Lab                      | All except E&TCE                     |
| MD8     | Embedded Systems- (ES)                    | Embedded Systems (ES)                                      | Fundamental of Microcontroller (FM) & Lab            | Embedded Processors –I (EP -I) & Lab                                | Microcontrollers and IoT (MI) & Lab                                                                    | Embedded Systems and RTOS (ES-RTOS) & Lab          | All Except E&TCE                     |
| MD9     | AI & Machine Learning (AI-ML)             | AI & Machine Learning (AI-ML)                              | Statistical Data Analysis & Lab                      | Machine Learning (ML) & Lab                                         | Natural Language Processing (NLP) & Lab                                                                | Artificial Intelligence (AI) & Lab                 | E&CE                                 |
| MD10    | Quantum Computing (QC)                    | Foundations of Quantum Technologies & Lab                  | Foundations of Quantum Computing Lab                 | Basic Programming for Scientific Computing Lab                      | Introduction to Quantum Computation Lab                                                                | Mini Project / Case Study Lab (MP/CS)              | ALL                                  |



## Annexure -II

### Guidelines for Open elective Courses

- Open Elective – I will be offered in the third semester as foreign language as prescribed in the structure.
- Open Electives – II, III, IV will be offered through SWAYAM/NPTEL MOOCs of Equivalent Credits.
- Departments will prepare the baskets/list of courses to be offered at the start of every semester, Students may choose any one course from the basket with adhering to any one stream.
- The department shall appoint a faculty mentor to ensure monitoring and course registration smoothly. The load for faculty should be reflected in the time table.
- Equivalent Teaching Scheme, credits and examination schemes are detailed in table below.
- End semester Evaluation: No separate examination is conducted by the institute.

|     |             |                                | Teaching Scheme<br>(Hours/Week) |   |   |       | Credits |   |   |       | Examination Scheme and Marks |      |      |           |     |    |       |
|-----|-------------|--------------------------------|---------------------------------|---|---|-------|---------|---|---|-------|------------------------------|------|------|-----------|-----|----|-------|
| Sem | Course code | Name of the Course             | L                               | P | T | Total | L       | P | T | Total | Theory                       |      |      | Practical |     |    | Total |
|     |             |                                |                                 |   |   |       |         |   |   |       | CIE                          | ISE  | ESE  | CIE       | ESE |    |       |
|     |             |                                |                                 |   |   |       |         |   |   |       | [20]                         | [20] | [60] | TW        | P   | OR |       |
| 3   | OE-I        | Foreign Language Studies (FLS) | -                               | - | 2 | 2     | -       | - | 2 | 2     | -                            | -    | -    | 50        | -   | -  | 50    |
| 4   | OE-II       | MOOCs                          | -                               | - | 2 | 2     | -       | - | 2 | 2     | -                            | -    | 50   | -         | -   | -  | 50    |
| 5   | OE-III      | MOOCs                          | -                               | - | 2 | 2     | -       | - | 2 | 2     | -                            | -    | 50   | -         | -   | -  | 50    |
| 6   | OE-IV       | MOOCs                          | -                               | - | 2 | 2     | -       | - | 2 | 2     | -                            | -    | 50   | -         | -   | -  | 50    |

## Guidelines for MOOCs

1. The department shall release a list of approved SWAYAM-NPTEL courses before the commencement of every semester.
2. Students shall register for the approved Courses as per the schedule announced by SWAYAM-NPTEL.
3. A student shall undergo the courses only from the list notified by the department through SWAYAM/NPTEL platform and complete all the assignments and examination requirements as specified by SWAYAM/NPTEL.
4. SWAYAM-NPTEL Courses are considered for transfer of credits only if the student concerned has successfully completed and obtained the SWAYAM-NPTEL Certificate.
5. The credit equivalence for SWAYAM-NPTEL Courses: 12 weeks – 3 credits; 8 weeks – 2 credits; 4 weeks – 1 credit.
6. Equivalent marks will be considered for awarding the grades as specified in examination rules and regulations. The weightage for assignments is 40%, while the weightage for the proctored examination will be 60% for award calculating SGPA/CGPA. Students must score a minimum of 40% of the total marks by combining both assignments and proctored examinations
7. A student must submit the original SWAYAM-NPTEL Course Certificates to the Head of the Department concerned, with a written request for the transfer of the equivalent credits. On verification of the SWAYAM-NPTEL Course Certificates and approval by the head of the department, credits will be awarded.
8. The Institute shall not reimburse any fees/expenses a student may incur for the SWAYAM-NPTEL Courses.
9. If the SWAYAM/NPTEL course calendar does not align with the institute's calendar, the department shall facilitate and conduct examination of the relevant course of equivalent credits in physical/virtual mode and award the credits accordingly.

## Guidelines for Evaluation

**Continuous Internal Evaluation:** (Weightage for Attendance: 5, Activity Based Learning Evaluation: 15)

The department shall declare the set of all applicable activities such as Problem Based Learning, Quizzes, Small Project, field work, group discussion, but not limited to etc. The course coordinator, in consultation with course teachers, shall select any two activities suitable for the course from the list declared by the department and get the selected activities approved from HoD. The Course teacher shall get the activities carried out by students, evaluate the student performance based on the prescribed rubrics. The department shall prepare the rubrics for all the activities and display the same before the commencement of academics.

In-Semester Examination: Written examination shall be conducted for one hour duration on First Module for 20 marks. End-Semester Examination: Written examination shall be conducted for two- and half-hour duration on Modules II, III, IV for 60 marks.



## **Annexure - III**

### **Relevant topics for self study:**

These topics are optional and suggested for students for self study to get additional exposure. However, these topics will not be considered for any evaluation and credits.

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# Annexure - IV

## Honors Course (HC)

### Guidelines for B. Tech Honors Program (As per NEP 2020)

#### 1. Objective

The Honors program is designed to provide advanced knowledge and deeper specialization in the student's major discipline. It aims to encourage academic excellence, research orientation, and advanced technical competency, enabling students to gain expertise beyond the standard B. Tech curriculum.

#### 2. Eligibility

- Students enrolled in the B. Tech program are eligible to opt for the Honors program.
- The option for Honors shall normally be available from Semester V to Semester VIII.
- Students should have successfully completed all courses up to Semester IV without backlog, or as per institute regulations.
- A minimum CGPA (for example 7.5 or as decided by the institute) may be required to enroll in the Honors program.
- The number of students allowed for Honors may be limited based on academic performance and departmental capacity.

#### 3. Credit Requirement

- Students must complete 20 additional credits in advanced courses of their major discipline.
- These credits shall be over and above the 160 credits required for the regular B. Tech program.
- The courses may include advanced electives, research-oriented subjects, laboratory work, or project-based learning.

#### 4. Structure of Honors Program

2. The Honors program shall normally consist of 4–5 advanced courses totaling 20 credits.
3. These courses shall be offered during Semester V to Semester VIII.
4. A typical credit distribution may be:

| Semester      | Course Type         | Credits |
|---------------|---------------------|---------|
| Semester V    | Honors Course – I   | 5       |
| Semester VI   | Honors Course – II  | 5       |
| Semester VII  | Honors Course – III | 6       |
| Semester VIII | Honors Course – IV  | 4       |

\*\*\*Institutions may modify the structure depending on curriculum requirements.

## 5. Course Selection Rules

- Honors courses must belong to the student's major discipline.
- The list of approved Honors courses shall be notified by the department.
- Honors courses should be advanced or specialized subjects beyond the core curriculum.
- Students must register for Honors courses as additional courses along with their regular semester workload.

## 6. Registration Procedure

- Interested students must apply for the Honors program at the beginning of Semester V.
- The registration shall be approved by the Head of the Department (HoD) of the parent department.
- Course registration shall follow the standard academic registration procedures of the institute.

## 7. Evaluation and Assessment

- Evaluation of Honors courses shall follow the same assessment and examination pattern as regular B. Tech courses.
- Students must secure the minimum passing grade as prescribed by the institute.
- If a student fails in an Honors course, they must clear the course as per institute examination rules.

## 8. Award of Honors Degree

- Students who successfully complete the 20 additional credits of Honors courses, along with the 160 credits required for the B. Tech program, will be awarded the degree as "B. Tech with Honors in <Discipline Name>."
- The Honors specialization will be mentioned on the degree certificate and academic transcript.

## 9. Exit Option

If a student does not complete all the required Honors credits, the additional credits earned may be recorded in the academic transcript, but the Honors distinction will not be awarded.

Available courses are as below

| Sr. No | Course Name                             | Mentor Dept. | Remark              |
|--------|-----------------------------------------|--------------|---------------------|
| 1.     | <b>VLSI Design Technology (VLSI-DT)</b> | E&TCE        | For all E&TCE, E&CE |
| 2.     | <b>Block Chain Technology (BCT)</b>     | CE           | For all CE, AIDS    |
| 3.     | <b>Internet of Things (IoT)</b>         | IT           | For all IT          |

## About Blockchain Technology

*The Honors course in Blockchain Technology is designed to provide in-depth knowledge and advanced specialization within the Computer Engineering domain. Spanning from Semester 5 to Semester 8, the course integrates theoretical concepts with practical laboratory work to build a strong foundation in blockchain systems and applications. It begins with fundamentals such as distributed ledger technology, blockchain architecture, and cryptographic principles, enabling students to understand secure and decentralized transaction systems.*

*As the course progresses, students explore key blockchain platforms like Bitcoin and Ethereum, along with consensus mechanisms such as Proof of Work and Proof of Stake. The curriculum further emphasizes smart contracts and Solidity programming, enabling learners to design and deploy decentralized applications (DApps). Advanced topics such as blockchain security, performance optimization, and real-world applications across domains like finance, healthcare, and supply chain are also covered.*

*The inclusion of laboratory sessions ensures hands-on experience in developing blockchain solutions, performing transactions, and building practical systems such as secure voting or certificate verification. Importantly, this course prepares students for future technologies such as Web 3.0, decentralized finance (DeFi), digital identity systems, and secure IoT ecosystems. With increasing industry adoption, it enhances career opportunities in roles like blockchain developer, smart contract engineer, and cybersecurity specialist. The practical exposure and industry-relevant skills significantly improve employability and placement prospects in emerging technology-driven companies and startups.*

## Course Structure Honors: Blockchain Technology (BT)

|     |                |                                   | Teaching Scheme<br>(Hours/Week) |    |   |       | Credits/ Grades |   |   |       | Examination Scheme and Marks |      |      |           |          |      |       |
|-----|----------------|-----------------------------------|---------------------------------|----|---|-------|-----------------|---|---|-------|------------------------------|------|------|-----------|----------|------|-------|
| Sem | Course<br>code | Name of the Course                | L                               | P  | T | Total | L               | P | T | Total | Theory                       |      |      | Practical |          |      | Total |
|     |                |                                   |                                 |    |   |       |                 |   |   |       | ISE                          | CIE  | ESE  | CIE [50]  | ESE [50] |      |       |
|     |                |                                   |                                 |    |   |       |                 |   |   |       | [20]                         | [20] | [60] | TW        | (P)      | (OR) |       |
| 5   | 2605HC11       | Fundamental of Blockchain         | 4                               | -  | - | 4     | 4               | - | - | 4     | 20                           | 20   | 60   | -         | -        | -    | 100   |
| 5   | 2605HC31       | Fundamental of Blockchain Lab     | -                               | 2  | - | 2     | -               | 1 | - | 1     | -                            | -    | -    | 25        | 25       | -    | 50    |
| 6   | 2606HC11       | Smart contracts and solidity      | 4                               | -  | - | 4     | 4               | - | - | 4     | 20                           | 20   | 60   | -         | -        | -    | 100   |
| 6   | 2606HC31       | Smart contracts and solidity Lab  | -                               | 2  | - | 2     | -               | 1 | - | 1     | -                            | -    | -    | 25        | 25       | -    | 50    |
| 7   | 2607HC11       | Blockchain platforms and Security | 3                               | -  | - | 3     | 3               | - | - | 3     | 20                           | 20   | 60   | -         | -        | -    | 100   |
| 7   | 2607HC31       | Major Project: Stage-I            | -                               | 6  | - | 3     | -               | 3 | - | 3     | -                            | -    | -    | 25        | -        | 25   | 50    |
| 8   | 2608HC31       | Major Project: Stage-II           | -                               | 8  | - | 4     | -               | 4 | - | 4     | -                            | -    | -    | 25        | -        | 25   | 50    |
|     |                | Total                             | 11                              | 18 | - | 22    | 11              | 9 | - | 20    | 60                           | 60   | 180  | 100       | 50       | 50   | 500   |

| Third Year B. Tech (T. Y B. Tech) AY (2026-27)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                    |                 |                                                 |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------|-----------------|-------------------------------------------------|
| Computer Engineering (CE)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                    |                 |                                                 |
| [2605HC11]: Fundamentals of Blockchain (FB)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                    |                 |                                                 |
| Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Credits                                                            | Teaching Scheme | Examination Scheme                              |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 4                                                                  | L: 04 Hrs/week  | CIE: 20 Marks<br>ISE: 20 Marks<br>ESE: 60 Marks |
| Prerequisite: Students should have prior knowledge of                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                    |                 |                                                 |
| <ul style="list-style-type: none"><li>Basic knowledge of Computer Networks, Databases, and Information Security</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                    |                 |                                                 |
| Course Objectives: The objective of this course is to provide students with                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                    |                 |                                                 |
| <ul style="list-style-type: none"><li>The basic concepts, architecture, and components of blockchain.</li><li>Cryptographic techniques and consensus mechanisms.</li><li>The working of Bitcoin and Ethereum blockchains.</li></ul>                                                                                                                                                                                                                                                                                                                                        |                                                                    |                 |                                                 |
| Course Outcomes: After completing this course, students will be able to:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                    |                 |                                                 |
| CO1: Apply the concepts of blockchain architecture and Distributed Ledger Technology to illustrate secure transactions.                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                    |                 |                                                 |
| CO2: Apply cryptographic techniques and consensus mechanisms to demonstrate data integrity and security in blockchain networks.                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                    |                 |                                                 |
| CO3: Analyze and differentiate major blockchain platforms and implementations based on their architecture and consensus models.                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                    |                 |                                                 |
| CO4: Design a blockchain based application.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                    |                 |                                                 |
| COURSE CONTENTS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                    |                 |                                                 |
| Module I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Introduction and fundamentals of Blockchain and Distributed Ledger |                 | 16 Hrs                                          |
| Basics of computer network, Centralized vs. decentralized systems, Peer to peer network, Evolution of blockchain technology, Distributed ledger technology (DLT), Blockchain architecture: Structure of a Block, Role of Nodes in Blockchain Networks, transactions, hash pointers, Hash chain, Immutability and Transparency in Blockchain Systems, Merkle trees, properties of Merkle tree, Types of blockchain: public, private, consortium, hybrid. Limitations and Challenges of Blockchain. Case study: Supply Chain Transparency, Blockchain in Financial Services. |                                                                    |                 |                                                 |
| Module II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Cryptography and Consensus Mechanisms                              |                 | 12 Hrs                                          |
| Security OSI architecture, Basics of cryptography, Number theory, Cryptographic hash functions (SHA-256), Characteristics of Hash function, Digital Signatures and Public-Private Key Cryptography, Data Security in Blockchain, Cryptographic algorithms in Blockchain, Consensus algorithms: Proof of Work, Proof of Stake, Delegated Proof of Stake, PBFT, Transaction validation and block creation. Case Study: Security of Blockchain – The Ethereum DAO Attack (2016).                                                                                              |                                                                    |                 |                                                 |
| Module III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Bitcoin and Ethereum Overview                                      |                 | 12 Hrs                                          |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                              |               |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|---------------|
| Introduction to Blockchain Platforms and Ecosystem, Bitcoin evolution, Bitcoin architecture, transactions and mining, consensus algorithms, Cold Wallets, Hot wallet and addresses, Ethereum architecture, EVM, Ethereum Gas fees, accounts, and gas, Proof of Stake, Comparison: Bitcoin vs Ethereum (Consensus algorithms, architecture and evolution). Case study: Smart Contracts and Decentralized Applications.                                                                                                                                                                                                                                                  |                                              |               |
| <b>Module IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>Applications and Future of Blockchain</b> | <b>12 Hrs</b> |
| Blockchain in finance (Cross-border payments, Decentralized Finance (DeFi), Trade finance, Digital currencies, Asset tokenization), healthcare (Electronic Health Records (EHR), Drug traceability, Clinical trials transparency, medical insurance claims), supply chain, and IoT, Scalability and interoperability issues, Future trends: Web 3.0, Metaverse, and decentralized identity. Case study of Real-world application implementation using Blockchain.                                                                                                                                                                                                      |                                              |               |
| <b>Text Books:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                              |               |
| <b>T1.</b> Martin Quest, <i>Blockchain Dynamics: A Quick Beginner's Guide on Understanding the Foundations of Bitcoin and Other Crypto currencies</i> , Create Space Independent Publishing Platform, 6 May 2018.<br><b>T2.</b> Imran Bashir, <i>Mastering Blockchain: Distributed Ledger Technology, Decentralization and Smart Contracts Explained</i> , Second Edition, Packt Publishing, 2018<br><b>T3.</b> Alex Leverington, <i>Ethereum Programming</i> , Packt Publishing, 31 July 2017.                                                                                                                                                                        |                                              |               |
| <b>Reference Books:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                              |               |
| <b>R1.</b> B. Singhal, G. Dhameja, and P. S. Panda, <i>Beginning Blockchain: A Beginner's Guide to Building Blockchain Solutions</i> , Berkeley, CA, USA: Apress, 2018.<br><b>R2.</b> C. Dannen, <i>Introducing Ethereum and Solidity: Foundations of Cryptocurrency and Blockchain Programming for Beginners</i> , Berkeley, CA, USA: Apress, 2017.<br><b>R3.</b> D. Drescher, <i>Blockchain Basics: A Non-Technical Introduction in 25 Steps</i> , Berkeley, CA, USA: Apress, 2017.<br><b>R5.</b> Subramanian, A. A. George, A. K. Abhilash, and M. Karthikeyan, <i>Blockchain Technology</i> , Hyderabad, India: Universities Press, 2018. ISBN: 978-93-89211-63-4. |                                              |               |
| <b>Relevant MOOCs Course:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                              |               |
| 3. NPTEL Course on –Introduction to Blockchain Technology & Applications<br><a href="https://nptel.ac.in/courses/106/104/106104220/">https://nptel.ac.in/courses/106/104/106104220/</a><br>4. NPTEL Course on - Cryptography and Network Security <a href="https://nptel.ac.in/courses/106105162">https://nptel.ac.in/courses/106105162</a>                                                                                                                                                                                                                                                                                                                            |                                              |               |

| <b>Third Year B. Tech (T. Y B. Tech) AY (2026-27)</b><br><b>Computer Engineering (CE)</b><br><b>[2605HC31]: Fundamental of Blockchain Lab (FBL)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                               |                        |                                                        |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|------------------------|--------------------------------------------------------|
| <b>Semester</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>Credit</b>                                                                                                                 | <b>Teaching Scheme</b> | <b>Examination Scheme</b>                              |
| <b>5</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>1</b>                                                                                                                      | <b>P: 2 Hrs./ Week</b> | <b>CIE (TW): 25 Marks</b><br><b>ESE (PR): 25 Marks</b> |
| <b>Prerequisite: Students should have prior knowledge of</b> <ul style="list-style-type: none"> <li>• Basic understanding of cryptographic concepts such as hashing, encryption, decryption, and digital signatures.</li> <li>• Understanding of public key and private key mechanisms, RSA or ECDSA algorithms, and the role of digital signatures in authentication and verification.</li> <li>• Basic knowledge of blockchain concepts including blocks, transactions, hashing, block linking, and the concept of distributed ledger technology.</li> <li>• Understanding of Ethereum wallets, blockchain transactions, and basic tools such as MetaMask, Ethereum test networks, and blockchain explorers.</li> </ul>                                                     |                                                                                                                               |                        |                                                        |
| <b>Course Objectives: The objective of this course is to provide students with</b> <ol style="list-style-type: none"> <li>2. <b>Understanding fundamental blockchain concepts</b> including cryptographic hash functions and their role in maintaining data integrity.</li> <li>3. <b>Application of cryptographic techniques</b> such as digital signatures and public key cryptography for securing blockchain transactions.</li> <li>4. <b>Design and implementation of basic blockchain structures</b> and perform blockchain transactions using Ethereum tools and platforms.</li> <li>5. <b>Design and analysis of blockchain-based solutions</b> for real-world applications such as certificate verification, voting systems, and supply chain management.</li> </ol> |                                                                                                                               |                        |                                                        |
| <b>Course Outcomes: After completing this course, students will be able to</b><br><b>CO1:</b> Apply distributed ledger technology, and cryptographic hash functions.<br><b>CO2:</b> Apply cryptographic techniques such as hashing and digital signatures for securing blockchain transactions.<br><b>CO3:</b> Develop simple blockchain structures and perform blockchain-based transactions using Ethereum tools.<br><b>CO4:</b> Design blockchain-based solutions for real-world applications.                                                                                                                                                                                                                                                                             |                                                                                                                               |                        |                                                        |
| <b>Assignment List</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                               |                        |                                                        |
| <b>Expt. No.</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <b>Problem Statement</b>                                                                                                      | <b>CO's</b>            |                                                        |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Implement a program to generate hash values for input data and demonstrate how small changes in input affect the output hash. | <b>CO1</b>             |                                                        |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Implement RSA or ECDSA-based signing and verification for transaction data.                                                   | <b>CO2</b>             |                                                        |
| 3.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Create a list-based blockchain where each block stores data, hash, and previous hash.                                         | <b>CO2</b>             |                                                        |

|    |                                                                                                                                                                                                                                                 |            |
|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| 4. | Create an Ethereum wallet and perform a test transaction.                                                                                                                                                                                       | <b>C03</b> |
| 5. | Mini Project (Any one): <ul style="list-style-type: none"> <li>• Blockchain-based Academic Certificate Verification System</li> <li>• Blockchain-based Secure Voting System</li> <li>• Blockchain-based Supply Chain Tracking System</li> </ul> | <b>C04</b> |

| Third Year B. Tech (T. Y B. Tech) AY (2026-27)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                         |                  |                                                 |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|------------------|-------------------------------------------------|
| Computer Engineering (CE)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                         |                  |                                                 |
| [2606HC11]: Smart Contracts and Solidity (SCS)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                         |                  |                                                 |
| Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Credits                                 | Teaching Scheme  | Examination Scheme                              |
| 6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 4                                       | L: 04 Hrs. /week | CIE: 20 Marks<br>ISE: 20 Marks<br>ESE: 60 Marks |
| Prerequisite: Students should have prior knowledge of <ul style="list-style-type: none"><li>Blockchain fundamentals</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                         |                  |                                                 |
| Course Objectives: The objective of this course is to provide students with <ul style="list-style-type: none"><li>Understanding of smart contracts and their real-world use.</li><li>Development of proficiency in Solidity programming and DApp development.</li><li>Understanding of smart contract security and testing.</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                         |                  |                                                 |
| Course Outcomes: After completing this course, students will be able to:<br>CO1: Understand the purpose and use of smart contracts.<br>CO2: Develop simple Solidity-based smart contracts.<br>CO3: Design and deploy DApps on Ethereum test networks.<br>CO4: Apply secure coding practices for reliable DApp deployment.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                         |                  |                                                 |
| COURSE CONTENTS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                         |                  |                                                 |
| Module I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Smart Contracts: Concepts and Use Cases | 16 Hrs           |                                                 |
| Concept of blockchain transactions, Structure of a blockchain transaction, Transaction inputs and outputs, Transaction verification and validation, Role of cryptographic signatures in transactions, Transaction propagation in peer-to-peer networks, Transaction confirmation and inclusion in blocks.Evolution from traditional contracts to programmable contracts, Smart contracts in blockchain platforms, Introduction to programming logic in smart contracts, Deterministic execution in blockchain networks, Overview of smart contract languages (e.g., Solidity), Deployment of smart contracts on blockchain platforms, Interaction between users and smart contracts, Gas and execution cost concepts, Security considerations in smart contract development, Applications and Use Cases of Smart Contracts (Token systems and Decentralized voting) |                                         |                  |                                                 |
| Module II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Introduction to Solidity and EVM        | 12 Hrs           |                                                 |
| Overview of the architecture and role of the Ethereum Virtual Machine (EVM) as a decentralized execution environment responsible for running smart contract code across all nodes in the network. The basic concepts of Solidity, program structure, and compilation. Key programming constructs such as <b>data types</b> (integers, booleans, addresses, and strings), variables, arrays, and mappings. Overall structure of a Solidity contract (state variables, constructors, functions, and event declarations)                                                                                                                                                                                                                                                                                                                                               |                                         |                  |                                                 |
| Module III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Advanced Solidity and DApp Development  | 12 Hrs           |                                                 |
| Solidity concepts - inheritance and libraries for modular smart contract development. Smart contract deployment using development tools such as Remix, Truffle, and Ganache. Interaction with deployed smart contracts using Web3.js. Integration of smart contracts with decentralized application (DApp)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                         |                  |                                                 |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                            |               |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------|---------------|
| front-end interfaces to enable blockchain-based transactions and data access.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                            |               |
| <b>Module IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <b>Smart Contract Testing and Security</b> | <b>12 Hrs</b> |
| Common smart contract vulnerabilities - reentrancy, integer overflow/underflow, and denial-of-service attacks. Techniques for identifying and mitigating security risks in blockchain applications. Use of testing frameworks and debugging tools for validating contract functionality. Smart contract auditing methods, gas optimization techniques, and best practices for designing secure, efficient, and reliable decentralized applications.                                                                                                                                                                                                                                                           |                                            |               |
| <b>Text Books</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                            |               |
| <ul style="list-style-type: none"> <li>• Martin Quest, <i>Blockchain Dynamics: A Quick Beginner's Guide on Understanding the Foundations of Bitcoin and Other Crypto currencies</i>, Create Space Independent Publishing Platform, 6 May 2018.</li> <li>• Imran Bashir, <i>Mastering Blockchain: Distributed Ledger Technology, Decentralization and Smart Contracts Explained</i>, Second Edition, Packt Publishing, 2018</li> <li>• Alex Leverington, <i>Ethereum Programming</i>, Packt Publishing, 31 July 2017.</li> </ul>                                                                                                                                                                               |                                            |               |
| <b>Reference Books:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                            |               |
| <ol style="list-style-type: none"> <li>6. Bikramaditya Singhal, Gautam Dhameja, Priyansu Sekhar Panda, <i>Beginning Blockchain A Beginner's Guide to Building Blockchain Solutions</i>, 2018</li> <li>7. Chris Dannen, <i>Introducing Ethereum and Solidity</i>, Foundations of Cryptocurrency and Blockchain Programming for Beginners</li> <li>8. Daniel Drescher, <i>Blockchain Basics</i>, A Non -Technical Introduction in 25 Steps.</li> <li>9. Ritesh Modi, <i>Solidity Programming Essentials</i>, Packt Publishing, 2018</li> <li>10. Chandramouli Subramanian, Asha A George, Abhilash K A and Meena Karthikeyan, <i>Blockchain Technology</i>, Universities Press, ISBN-97893892116343.</li> </ol> |                                            |               |
| <b>Relevant MOOCs Course:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                            |               |
| <ul style="list-style-type: none"> <li>• NPTEL Course on Introduction to Blockchain Technology &amp; Applications<br/> <a href="https://nptel.ac.in/courses/106/104/106104220/">https://nptel.ac.in/courses/106/104/106104220/</a> </li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                            |               |

| <b>Third Year B. Tech (T. Y B. Tech) AY (2026-27)</b><br><b>Computer Engineering (CE)</b><br><b>[2606HC31]: Smart Contracts and Solidity Lab (SCSL)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                        |                 |                                          |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|------------------------------------------|
| Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Credits                                                                                                                                                                                                | Teaching Scheme | Examination Scheme                       |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 1                                                                                                                                                                                                      | P: 2 Hrs./ Week | CIE(TW) : 25 Marks<br>ESE(PR) : 25 Marks |
| <b>Prerequisite: Students should have prior knowledge of</b> <ol style="list-style-type: none"> <li>4. Familiarity with cryptographic concepts such as hashing and digital signatures.</li> <li>5. Basic understanding of web technologies such as HTML, JavaScript, and APIs.</li> <li>6. Awareness of Ethereum platform and smart contract concepts.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                        |                 |                                          |
| <b>Course Objectives: The objective of this course is to provide students with</b> <ol style="list-style-type: none"> <li>Understanding of the fundamentals of Solidity programming and developing simple smart contracts for storing and managing data on the blockchain.</li> <li>Design and implementation of token-based smart contracts and understand token standards and transaction mechanisms in Ethereum.</li> <li>Development of decentralized applications (DApps) by integrating smart contracts with front-end applications using tools such as Web3.js.</li> <li>Analyze the smart contract vulnerabilities and apply secure coding practices to improve the reliability and security of blockchain applications.</li> </ol> |                                                                                                                                                                                                        |                 |                                          |
| <b>Course Outcomes: After completing this course, students will be able to</b><br><b>CO1:</b> Develop and deploy basic smart contracts using Solidity on Ethereum development environments such as Remix or Truffle.<br><b>CO2:</b> Implement and test token-based smart contracts and perform transactions between blockchain accounts.<br><b>CO3:</b> Build simple decentralized applications (DApps) that interact with deployed smart contracts.<br><b>CO4:</b> Identify common smart contract security vulnerabilities and apply best practices for secure smart contract design.                                                                                                                                                      |                                                                                                                                                                                                        |                 |                                          |
| Assignment List                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                        |                 |                                          |
| Expt. No.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Problem Statement                                                                                                                                                                                      | CO's            |                                          |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Write and deploy a simple smart contract using Solidity that stores and retrieves data on the blockchain. Implement functions for setting and getting values, and deploy the contract using Remix IDE. | CO1             |                                          |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Design and implement a basic ERC-20 token smart contract in Solidity. Include functionalities such as token creation, balance checking, and token transfer between accounts.                           | CO2             |                                          |
| 3.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Develop a simple front-end application that interacts with a deployed smart contract using Web3.js.                                                                                                    | CO3             |                                          |
| 4.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Analyze a given Solidity smart contract and identify potential vulnerabilities such as reentrancy, integer overflow, and denial of service.                                                            | CO4             |                                          |

|    |                                                                                                                                                                                                    |                                                      |
|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------|
| 5. | Mini project <ul style="list-style-type: none"> <li>Decentralized Crowdfunding Platform</li> <li>Digital Identity Management System</li> <li>Blockchain-based Student Attendance System</li> </ul> | <b>C01</b><br><b>C02</b><br><b>C03</b><br><b>C04</b> |
|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------|

## About: VLSI Design Technology

*This course on VLSI Design Technology provides students with a comprehensive understanding of designing modern electronic systems at the chip level. It integrates concepts of CMOS design, digital logic, embedded systems, and system-on-chip (SoC) development, along with hands-on exposure to industry-standard EDA tools such as Cadence, Vivado, and ModelSim. Through a combination of theory, laboratory work, and a major project, students gain practical experience in the complete design flow—from RTL design to physical implementation and testing.*

*In the real world, VLSI plays a crucial role in the development of almost all electronic devices, including smartphones, laptops, IoT systems, automotive electronics, medical devices, and communication systems. The demand for efficient, low-power, and high-performance chips has made VLSI one of the most important domains in the semiconductor industry. This course equips students with the skills required to contribute to such cutting-edge technologies.*

*The knowledge gained opens up diverse career opportunities such as VLSI design engineer, verification engineer, FPGA developer, embedded systems engineer, and ASIC design engineer. Students can work in core semiconductor companies, electronics industries, and research organizations. Additionally, the course promotes research-oriented thinking, enabling students to pursue higher studies or innovation in emerging areas like AI hardware accelerators, IoT chips, and low-power design.*

*Overall, this course bridges academic learning with industry requirements, making students well-prepared for careers in the rapidly growing semiconductor and electronics domain.*

### Course Structure Honors: VLSI Design Technology (VDT)

|     |                      |                                       | Teaching Scheme<br>(Hours/Week) |    |   |       | Credits |   |   |       | Examination/ Evaluation Scheme and Marks |          |      |           |     |    |       |
|-----|----------------------|---------------------------------------|---------------------------------|----|---|-------|---------|---|---|-------|------------------------------------------|----------|------|-----------|-----|----|-------|
| Sem | Course<br>code       | Name of the Course                    | L                               | P  | T | Total | L       | P | T | Total | Theory                                   |          |      | Practical |     |    | Total |
|     |                      |                                       |                                 |    |   |       |         |   |   |       | ISE                                      | CIE      | ESE  | CIE       | ESE |    |       |
|     |                      |                                       |                                 |    |   |       |         |   |   |       | [20<br>]                                 | [20<br>] | [60] | TW        | P   | OR |       |
| 5   | 2625HC11             | VLSI Design and Embedded Systems      | 4                               | -  | - | 4     | 4       | - | - | 4     | 20                                       | 20       | 60   | -         | -   | -  | 100   |
| 5   | 2625HC31             | VLSI Design and Embedded Systems Lab  | -                               | 2  | - | 2     | -       | 1 | - | 1     | -                                        | -        | -    | -         | 25  | -  | 25    |
| 6   | 2626HC12             | VLSI Design and Signal Processing     | 4                               | -  | - | 4     | 4       | - | - | 4     | 20                                       | 20       | 60   | -         | -   | -  | 100   |
| 6   | 2626HC32             | VLSI Design and Signal Processing Lab | -                               | 2  | - | 2     | -       | 1 | - | 1     | -                                        | -        | -    | -         | 25  | -  | 25    |
| 7/8 | 2627HC13<br>2628HC13 | VLSI System Design                    | 4                               | -  | - | 4     | 4       | - | - | 4     | 20                                       | 20       | 60   | -         | -   | -  | 100   |
| 7/8 | 2627HC33<br>2628HC13 | VLSI System Design Lab                | -                               | 4  | - | 4     | -       | 2 | - | 2     | -                                        | -        | -    | -         | 50  | -  | 50    |
| 7/8 | 2628HC34             | Major Project / Dissertation in VLSI  | -                               | 8  | - | 8     | -       | 4 | - | 4     | -                                        | -        | -    | 50        | -   | 50 | 100   |
|     |                      | Total                                 | 12                              | 16 | 0 | 28    | 12      | 8 | 0 | 20    | 60                                       | 60       | 180  | 50        | 100 | 50 | 500   |

| Third Year B-TECH (TY B-Tech) (2026-27)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                               |                 |                                                 |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------|-----------------|-------------------------------------------------|
| Electronics and Telecommunication Engineering (E&TCE)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                               |                 |                                                 |
| [2625HC11]: VLSI Design and Embedded Systems (VDES)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                               |                 |                                                 |
| Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Credits                                       | Teaching Scheme | Examination Scheme                              |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 4                                             | L: 4 Hrs./ Week | ISE: 20 Marks<br>CIE: 20 Marks<br>ESE: 60 Marks |
| <b>Prerequisite:</b> Students should have prior knowledge of <ul style="list-style-type: none"><li>Digital electronics (logic gates, Boolean algebra, number systems)</li><li>Basic C programming</li><li>Fundamentals of microprocessors/ microcontrollers</li></ul>                                                                                                                                                                                                                                                                                                                 |                                               |                 |                                                 |
| <b>Course Objectives:</b> The objective of this course is to provide students with <ul style="list-style-type: none"><li>A strong understanding of CMOS VLSI concepts and digital logic implementation.</li><li>The skills to design, simulate, and synthesize digital circuits using HDL.</li><li>Hands-on knowledge of embedded hardware-software integration and SoC-based applications.</li></ul>                                                                                                                                                                                 |                                               |                 |                                                 |
| <b>Course Outcomes:</b> After completing this course, students will be able to<br><i>CO1: Explain</i> MOS transistor characteristics, CMOS inverter behavior, and logic gate implementation.<br><i>CO2: Develop</i> digital circuits using Verilog/VHDL and perform simulation and synthesis using tools like ModelSim or Vivado.<br><i>CO3: Examine</i> the hardware-software interfacing of embedded systems, including I/O peripherals and communication protocols.<br><i>CO4: Design and implement</i> SoC-based embedded VLSI solutions for real-world applications such as IoT. |                                               |                 |                                                 |
| COURSE CONTENT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                               |                 |                                                 |
| Module-I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | CMOS VLSI Fundamentals                        |                 | 13 Hrs.                                         |
| MOS transistor theory and characteristics, CMOS inverter: static & dynamic behavior, Logic gate design (NAND, NOR, XOR, complex gates), Layout design rules and stick diagrams                                                                                                                                                                                                                                                                                                                                                                                                        |                                               |                 |                                                 |
| Module-II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Digital Circuit Design using HDL              |                 | 13 Hrs.                                         |
| Verilog/VHDL: syntax, data types, modeling styles, Combinational and sequential circuits (adders, counters, registers), Testbench creation and simulation using ModelSim/ Vivado, Synthesis and timing analysis basics                                                                                                                                                                                                                                                                                                                                                                |                                               |                 |                                                 |
| Module-III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Embedded System Hardware-Software Integration |                 | 2. Hrs                                          |
| Embedded processor architecture (ARM/AVR/RISC-V), Memory, I/O interfacing (ADC/DAC, sensors), Serial communication protocols (UART, SPI, I <sup>2</sup> C), Embedded C for peripheral control                                                                                                                                                                                                                                                                                                                                                                                         |                                               |                 |                                                 |
| Module-IV                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | System-on-Chip (SoC) Design and Applications  |                 | 13 Hrs.                                         |
| SoC architecture and IP integration, Hardware-software co-design concepts, FPGA-based SoC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                               |                 |                                                 |

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| implementation, Case study: Embedded VLSI for IoT applications                                                                                                                                                                                                                                                                                                                           |                                                                                                                              |
| <b>Text Book:</b>                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                              |
| <b>T1.</b>                                                                                                                                                                                                                                                                                                                                                                               | <i>N. H. E. Weste and D. Harris, CMOS VLSI Design: A Circuits and Systems Perspective, 4th ed. Pearson Education, 2010</i>   |
| <b>T2.</b>                                                                                                                                                                                                                                                                                                                                                                               | D. Harris and S. Harris, Digital Design and Computer Architecture, 2nd ed. Morgan Kaufmann (Elsevier), 2012.                 |
| <b>Reference Books:</b>                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                              |
| <b>R1.</b>                                                                                                                                                                                                                                                                                                                                                                               | <i>D. A. Pucknell and K. Eshraghian, Basic VLSI Design, 3rd ed. Prentice Hall of India, 2005.</i>                            |
| <b>R2.</b>                                                                                                                                                                                                                                                                                                                                                                               | F. Vahid and T. Givargis, Embedded System Design: A Unified Hardware/Software Introduction, 2nd ed. John Wiley & Sons, 2006. |
| <b>Relevant MOOCs Course (Course name and Weblink)</b>                                                                                                                                                                                                                                                                                                                                   |                                                                                                                              |
| <ul style="list-style-type: none"> <li>• VLSI Physical Design, IIT Kharagpur, Prof. Indranil Sengupta<br/>Link: <a href="https://nptel.ac.in/courses/106105161">https://nptel.ac.in/courses/106105161</a></li> <li>• Embedded Systems, IIT Delhi, Prof. Santanu Chaudhary<br/>Link: <a href="https://nptel.ac.in/courses/108102045">https://nptel.ac.in/courses/108102045</a></li> </ul> |                                                                                                                              |
| <b>Relevant Topic for Self-study:</b>                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                              |
|                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                              |

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| Third Year B-TECH (TY B-Tech) (2026-27)                                                                                                                                                                                                                                   |                                                                                                                                          |                 |                    |
| Electronics and Telecommunication Engineering (E&TCE)                                                                                                                                                                                                                     |                                                                                                                                          |                 |                    |
| [2625HC31]: VLSI Design and Embedded Systems Lab (VDESL)                                                                                                                                                                                                                  |                                                                                                                                          |                 |                    |
| Semester                                                                                                                                                                                                                                                                  | Credits                                                                                                                                  | Teaching Scheme | Examination Scheme |
| 5                                                                                                                                                                                                                                                                         | 1                                                                                                                                        | P: 2 Hrs./ Week | ESE (P): 25 Marks  |
| <b>Prerequisite:</b> Students should have prior knowledge of                                                                                                                                                                                                              |                                                                                                                                          |                 |                    |
| <ul style="list-style-type: none"><li>Digital electronics (logic gates, Boolean algebra, number systems)</li><li>Basic C programming</li><li>Fundamentals of microprocessors/microcontrollers</li></ul>                                                                   |                                                                                                                                          |                 |                    |
| <b>Course Objectives:</b> The objective of this course is to provide students with                                                                                                                                                                                        |                                                                                                                                          |                 |                    |
| <ul style="list-style-type: none"><li>Hands-on experience in digital and embedded system design using HDL, EDA tools, and SoC platforms.</li><li>Skills in integrating sensors, processors, and programmable logic for real-time embedded and IoT applications.</li></ul> |                                                                                                                                          |                 |                    |
| <b>Course Outcomes:</b> After completing this course, students will be able to                                                                                                                                                                                            |                                                                                                                                          |                 |                    |
| CO1: Design, simulate, and verify digital circuits using HDL and industry tools.                                                                                                                                                                                          |                                                                                                                                          |                 |                    |
| CO2: Implement and integrate embedded hardware–software systems and SoC-based applications.                                                                                                                                                                               |                                                                                                                                          |                 |                    |
| COURSE CONTENT                                                                                                                                                                                                                                                            |                                                                                                                                          |                 |                    |
| Expt. No                                                                                                                                                                                                                                                                  | Title/Problem Statement                                                                                                                  |                 | CO                 |
| 1.                                                                                                                                                                                                                                                                        | Design and simulate CMOS inverter using Cadence/Mentor tools.                                                                            |                 | CO1                |
| 2.                                                                                                                                                                                                                                                                        | Implement and verify combinational circuits (NAND/NOR logic families) in HDL.                                                            |                 | CO1                |
| 3.                                                                                                                                                                                                                                                                        | HDL implementation of 4-bit ALU and timing verification.                                                                                 |                 | CO1                |
| 4.                                                                                                                                                                                                                                                                        | Design of finite state machine (traffic light or vending machine).                                                                       |                 | CO1                |
| 5.                                                                                                                                                                                                                                                                        | Interface temperature sensor with ARM/ESP32 using UART/SPI.                                                                              |                 | CO2                |
| 6.                                                                                                                                                                                                                                                                        | Develop embedded code to control peripheral device (e.g., DC motor or LED matrix).                                                       |                 | CO2                |
| 7.                                                                                                                                                                                                                                                                        | Implement SoC prototype integrating microcontroller and HDL logic block.                                                                 |                 | CO2                |
| 8.                                                                                                                                                                                                                                                                        | Demonstrate FPGA-based IoT node with sensor interface.                                                                                   |                 | CO2                |
| Text Books:                                                                                                                                                                                                                                                               |                                                                                                                                          |                 |                    |
| T1.                                                                                                                                                                                                                                                                       | N. H. E. Weste and D. Harris, CMOS VLSI Design: A Circuits and Systems Perspective, 4 <sup>th</sup> ed. Pearson Education, 2010          |                 |                    |
| T2.                                                                                                                                                                                                                                                                       | D. Harris and S. Harris, Digital Design and Computer Architecture, 2 <sup>nd</sup> ed. Morgan Kaufmann (Elsevier), 2012.                 |                 |                    |
| Reference Books:                                                                                                                                                                                                                                                          |                                                                                                                                          |                 |                    |
| R1.                                                                                                                                                                                                                                                                       | D. A. Pucknell and K. Eshraghian, Basic VLSI Design, 3 <sup>rd</sup> ed. Prentice Hall of India, 2005.                                   |                 |                    |
| R2.                                                                                                                                                                                                                                                                       | F. Vahid and T. Givargis, Embedded System Design: A Unified Hardware/Software Introduction, 2 <sup>nd</sup> ed. John Wiley & Sons, 2006. |                 |                    |
| Any Special Guidelines                                                                                                                                                                                                                                                    |                                                                                                                                          |                 |                    |

| Third Year B-TECH (TY B-Tech) (2026-27)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                             |                 |                                                 |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------|-----------------|-------------------------------------------------|
| Electronics and Telecommunication Engineering (E&TCE)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                             |                 |                                                 |
| [2626HC12]: VLSI Design and Signal Processing (VDSP)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                             |                 |                                                 |
| Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Credits                                     | Teaching Scheme | Examination Scheme                              |
| 6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 4                                           | L: 4 Hrs./ Week | ISE: 20 Marks<br>CIE: 20 Marks<br>ESE: 60 Marks |
| <b>Prerequisite:</b> Students should have prior knowledge of <ul style="list-style-type: none"><li>Digital electronics (logic gates, Boolean algebra)</li><li>C programming fundamentals</li><li>Microprocessor/microcontroller basics.</li><li>Number systems and basic circuit theory</li></ul>                                                                                                                                                                                                                                                                                          |                                             |                 |                                                 |
| <b>Course Objectives:</b> The objective of this course is to provide students with <ul style="list-style-type: none"><li>A foundational understanding of CMOS VLSI concepts and digital logic implementation.</li><li>Hands-on skills in HDL-based digital circuit simulation, verification, and synthesis.</li><li>The ability to integrate embedded hardware-software components and develop SoC-based applications.</li></ul>                                                                                                                                                           |                                             |                 |                                                 |
| <b>Course Outcomes:</b> After completing this course, students will be able to <p>CO1: Explain MOS transistor behavior, CMOS inverter operation, logic gate design, and layout rules.</p> <p>CO2: Develop and simulate combinational and sequential circuits using Verilog/VHDL with appropriate testbenches.</p> <p>CO3: Interpret embedded processor architectures and analyze hardware-software interfacing using communication protocols.</p> <p>CO4: Design and implement SoC-based embedded VLSI solutions for applications such as IoT using FPGA or microcontroller platforms.</p> |                                             |                 |                                                 |
| COURSE CONTENT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                             |                 |                                                 |
| Module-I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Digital VLSI Design and Timing              |                 | 13 Hrs.                                         |
| Review of CMOS circuits and sequential logic, Clocking, synchronization, and metastability, Setup/hold time analysis, Pipelining and throughput optimization                                                                                                                                                                                                                                                                                                                                                                                                                               |                                             |                 |                                                 |
| Module-II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Fundamentals of Digital Signal Processing   |                 | 13 Hrs.                                         |
| Discrete-time systems and convolution, FIR/IIR filter design principles, DFT/FFT concepts and hardware implications, Fixed vs floating-point arithmetic in hardware                                                                                                                                                                                                                                                                                                                                                                                                                        |                                             |                 |                                                 |
| Module-III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | VLSI Architectures for DSP                  |                 | 13 Hrs.                                         |
| Parallel and pipelined DSP architectures, Systolic arrays and MAC design, Low-power techniques for DSP processors, Real-time signal processing constraints                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                             |                 |                                                 |
| Module-IV                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Hardware-Software Co-Design for DSP Systems |                 | 13 Hrs.                                         |
| Mapping DSP algorithms onto hardware, Co-design and co-simulation tools, FPGA                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                             |                 |                                                 |

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| implementation and testing, Case studies: audio, biomedical, image processing                                                                                                                                                                                                                                                                                                            |                                                                                                                              |
| <b>Text Book:</b>                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                              |
| <b>T1.</b>                                                                                                                                                                                                                                                                                                                                                                               | <i>N. H. E. Weste and D. Harris, CMOS VLSI Design: A Circuits and Systems Perspective, 4th ed. Pearson Education, 2010</i>   |
| <b>T2.</b>                                                                                                                                                                                                                                                                                                                                                                               | D. Harris and S. Harris, Digital Design and Computer Architecture, 2nd ed. Morgan Kaufmann (Elsevier), 2012.                 |
| <b>Reference Books:</b>                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                              |
| <b>R1.</b>                                                                                                                                                                                                                                                                                                                                                                               | <i>D. A. Pucknell and K. Eshraghian, Basic VLSI Design, 3rd ed. Prentice Hall of India, 2005.</i>                            |
| <b>R2.</b>                                                                                                                                                                                                                                                                                                                                                                               | F. Vahid and T. Givargis, Embedded System Design: A Unified Hardware/Software Introduction, 2nd ed. John Wiley & Sons, 2006. |
| <b>Relevant MOOCs Course (Course name and Weblink)</b>                                                                                                                                                                                                                                                                                                                                   |                                                                                                                              |
| <ul style="list-style-type: none"> <li>• VLSI Physical Design, IIT Kharagpur, Prof. Indranil Sengupta<br/>Link: <a href="https://nptel.ac.in/courses/106105161">https://nptel.ac.in/courses/106105161</a></li> <li>• Embedded Systems, IIT Delhi, Prof. Santanu Chaudhary<br/>Link: <a href="https://nptel.ac.in/courses/108102045">https://nptel.ac.in/courses/108102045</a></li> </ul> |                                                                                                                              |
| <b>Relevant Topic for Self-study:</b>                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                              |
|                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                              |

| Third Year B-TECH (TY B-Tech) (2026-27)                                                                                                                                                                                                                                                                                                                             |                                                                                                                                          |                 |                    |
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| Electronics and Telecommunication Engineering (E&TCE)                                                                                                                                                                                                                                                                                                               |                                                                                                                                          |                 |                    |
| [2626HC32]: VLSI Design and Signal Processing Lab (VDSPL)                                                                                                                                                                                                                                                                                                           |                                                                                                                                          |                 |                    |
| Semester                                                                                                                                                                                                                                                                                                                                                            | Credits                                                                                                                                  | Teaching Scheme | Examination Scheme |
| 6                                                                                                                                                                                                                                                                                                                                                                   | 1                                                                                                                                        | P: 2 Hrs./ Week | ESE (P): 25 Marks  |
| <b>Prerequisite:</b> Students should have prior knowledge of <ul style="list-style-type: none"><li>Digital electronics (logic gates, Boolean algebra)</li><li>C programming fundamentals</li><li>Microprocessor/microcontroller basics.</li><li>Number systems and basic circuit theory</li></ul>                                                                   |                                                                                                                                          |                 |                    |
| <b>Course Objectives:</b> The objective of this course is to provide students with <ul style="list-style-type: none"><li>Proficiency in designing, simulating, and implementing DSP-oriented digital circuits using HDL and FPGA tools.</li><li>Provide hands-on experience in real-time signal processing using hardware platforms such as ARM and FPGA.</li></ul> |                                                                                                                                          |                 |                    |
| <b>Course Outcomes:</b> After completing this course, students will be able to<br>CO1: Design, simulate, and verify DSP-based digital circuits using HDL and EDA tools.<br>CO2: Implement and evaluate real-time signal processing applications on FPGA/ARM platforms.                                                                                              |                                                                                                                                          |                 |                    |
| COURSE CONTENT                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                          |                 |                    |
| Expt. No                                                                                                                                                                                                                                                                                                                                                            | Title/Problem Statement                                                                                                                  | CO              |                    |
| 1.                                                                                                                                                                                                                                                                                                                                                                  | Design and simulate a pipelined 4-bit multiplier in HDL.                                                                                 | CO1             |                    |
| 2.                                                                                                                                                                                                                                                                                                                                                                  | Timing simulation and clock skew analysis in Vivado.                                                                                     | CO1             |                    |
| 3.                                                                                                                                                                                                                                                                                                                                                                  | MATLAB design of FIR/IIR filters and HDL implementation.                                                                                 | CO1             |                    |
| 4.                                                                                                                                                                                                                                                                                                                                                                  | FFT design and simulation using Verilog.                                                                                                 | CO1             |                    |
| 5.                                                                                                                                                                                                                                                                                                                                                                  | HDL-based design of MAC (Multiply-Accumulate) unit.                                                                                      | CO1             |                    |
| 6.                                                                                                                                                                                                                                                                                                                                                                  | Implement 4-tap FIR filter on FPGA and analyze resource utilization.                                                                     | CO2             |                    |
| 7.                                                                                                                                                                                                                                                                                                                                                                  | Implement audio filter (low-pass or echo) using FPGA.                                                                                    | CO2             |                    |
| 8.                                                                                                                                                                                                                                                                                                                                                                  | Real-time signal acquisition and processing using ARM/FPGA board.                                                                        | CO2             |                    |
| Text Books:                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                          |                 |                    |
| T1.                                                                                                                                                                                                                                                                                                                                                                 | N. H. E. Weste and D. Harris, CMOS VLSI Design: A Circuits and Systems Perspective, 4 <sup>th</sup> ed. Pearson Education, 2010          |                 |                    |
| T2.                                                                                                                                                                                                                                                                                                                                                                 | D. Harris and S. Harris, Digital Design and Computer Architecture, 2 <sup>nd</sup> ed. Morgan Kaufmann (Elsevier), 2012.                 |                 |                    |
| Reference Books:                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                          |                 |                    |
| R1.                                                                                                                                                                                                                                                                                                                                                                 | D. A. Pucknell and K. Eshraghian, Basic VLSI Design, 3 <sup>rd</sup> ed. Prentice Hall of India, 2005.                                   |                 |                    |
| R2.                                                                                                                                                                                                                                                                                                                                                                 | F. Vahid and T. Givargis, Embedded System Design: A Unified Hardware/Software Introduction, 2 <sup>nd</sup> ed. John Wiley & Sons, 2006. |                 |                    |
| Any Special Guidelines                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                          |                 |                    |

## About Internet of Things

The Honors course in Internet of Things (IoT) is designed to provide advanced knowledge and hands-on expertise in building intelligent, connected systems. Spanning from Semester 5 to Semester 8, the course covers fundamental IoT concepts, embedded systems, communication protocols, cloud integration, and security aspects. Students begin with core topics such as IoT architecture, sensors, microcontrollers, and embedded programming, followed by deeper insights into networking technologies, protocols like MQTT and CoAP, and cloud platforms for data storage and visualization.

As the course progresses, emphasis is placed on IoT communication, edge and fog computing, and secure system design. Students also study real-world IoT applications in domains such as smart cities, healthcare, and industrial systems. The curriculum includes extensive laboratory work and a two-stage major project, enabling learners to design, develop, and deploy complete IoT-based solutions using modern tools and platforms.

This course plays a crucial role in preparing students for future technologies such as Industry 4.0, smart infrastructure, AI-enabled IoT systems, and cyber-physical systems. It enhances career opportunities in roles like IoT developer, embedded systems engineer, cloud IoT specialist, and automation engineer. The strong practical exposure, combined with research-oriented projects, significantly improves students' placement prospects in core engineering, IT industries, and emerging technology startups.

### Course Structure Honors: Internet of Things (IoT)

|     |                |                                                      | Teaching Scheme<br>(Hours/Week) |    |   |       | Credits |   |   |       | Examination/ Evaluation Scheme and Marks |          |      |           |     |    |       |
|-----|----------------|------------------------------------------------------|---------------------------------|----|---|-------|---------|---|---|-------|------------------------------------------|----------|------|-----------|-----|----|-------|
| Sem | Course<br>code | Name of the Course                                   | L                               | P  | T | Total | L       | P | T | Total | Theory                                   |          |      | Practical |     |    | Total |
|     |                |                                                      |                                 |    |   |       |         |   |   |       | ISE                                      | CIE      | ESE  | CIE       | ESE |    |       |
|     |                |                                                      |                                 |    |   |       |         |   |   |       | [20<br>]                                 | [20<br>] | [60] | TW        | P   | OR |       |
| 5   | 2635HC11       | Fundamentals of Internet of Things (FIoT)            | 3                               | -  | - | 3     | 3       | - | - | 3     | 20                                       | 20       | 60   | -         | -   | -  | 100   |
| 5   | 2635HC31       | Internet of Things Lab (IoTL)                        | -                               | 4  | - | 4     | -       | 2 | - | 2     | -                                        | -        | -    | 25        | -   | -  | 25    |
| 6   | 2636HC11       | IoT Communication and Cloud Technologies (ICCT)      | 3                               | -  | - | 3     | 3       | - | - | 3     | 20                                       | 20       | 60   | -         | -   | -  | 100   |
| 6   | 2636HC31       | IoT Communication and Cloud Technologies Lab (ICCTL) | -                               | 2  | - | 2     | -       | 1 | - | 1     | -                                        | -        | -    | 25        | -   | -  | 25    |
| 7/8 | 2637HC11       | IoT Security and Applications (ISA)                  | 3                               | -  | - | 3     | 3       | - | - | 3     | 20                                       | 20       | 60   | -         | -   | -  | 100   |
| 7/8 | 2637HC31       | Major Project: Stage-I                               | -                               | 8  | - | 8     | 4       | - | - | 4     | -                                        | -        | -    | 50        | -   | 25 | 75    |
| 7/8 | 2638HC31       | Major Project: Stage-II                              | -                               | 8  | - | 8     | 4       | - | - | 4     | -                                        | -        | -    | 50        | -   | 25 | 75    |
|     |                | Total                                                | 9                               | 22 | - | 31    | 17      | 3 | - | 20    | 60                                       | 60       | 180  | 150       | -   | 50 | 500   |

| Third Year B. Tech (T. Y B. Tech) AY (2026-27)                                                                                                                                                                                                                                                                                                                                                |                                    |                  |                                                 |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|------------------|-------------------------------------------------|
| Information Technology (IT)                                                                                                                                                                                                                                                                                                                                                                   |                                    |                  |                                                 |
| <b>[2635HC11]: Introduction to Internet of Things (IIoT)</b>                                                                                                                                                                                                                                                                                                                                  |                                    |                  |                                                 |
| Semester                                                                                                                                                                                                                                                                                                                                                                                      | Credits                            | Teaching Scheme  | Examination Scheme                              |
| 5                                                                                                                                                                                                                                                                                                                                                                                             | 3                                  | L: 3 Hrs. / Week | CIE: 20 Marks<br>ISE: 20 Marks<br>ESE: 60 Marks |
| <b>Prerequisite: Students should have prior knowledge of</b> <ul style="list-style-type: none"> <li>• C/C++ Programming</li> <li>• Fundamentals of Computer Networking</li> </ul>                                                                                                                                                                                                             |                                    |                  |                                                 |
| <b>Course Objectives: The objective of this course is to provide students with</b> <ol style="list-style-type: none"> <li>2. To understand core concepts and architecture of IoT</li> <li>3. To study hardware components used in IoT systems</li> <li>4. To learn embedded system design for IoT applications</li> <li>5. To implement basic IoT systems using embedded platforms</li> </ol> |                                    |                  |                                                 |
| <b>Course Outcomes: After completing this course, students will be able to</b><br><b>C01.</b> Explain IoT architecture, components, and communication models<br><b>C02.</b> Review and use IoT system components.<br><b>C03.</b> Explain various IoT hardware platforms.<br><b>C04.</b> Explain basic IoT system design using embedded platforms                                              |                                    |                  |                                                 |
| COURSE CONTENTS                                                                                                                                                                                                                                                                                                                                                                               |                                    |                  |                                                 |
| Module-I                                                                                                                                                                                                                                                                                                                                                                                      | Fundamentals of IoT                | 12 Hrs.          | C01                                             |
| Introduction to IoT: Definition, Features, Applications, IoT Architecture: 3-layer and 5-layer models, IoT Communication Models, IoT Protocols: MQTT, CoAP, HTTP. IoT vs M2M, Overview of IoT ecosystem.                                                                                                                                                                                      |                                    |                  |                                                 |
| Module-II                                                                                                                                                                                                                                                                                                                                                                                     | IoT System Components & Networking | 9 Hrs.           | C02                                             |
| Sensors and Actuators, IoT Nodes and Gateways, Data acquisition and processing, Basics of networking in IoT, Cloud and Fog computing in IoT, Introduction to data storage and visualization.                                                                                                                                                                                                  |                                    |                  |                                                 |
| Module-III                                                                                                                                                                                                                                                                                                                                                                                    | Hardware for IoT                   | 9 Hrs.           | C03                                             |
| Microcontrollers vs Microprocessors, IoT Hardware Platforms: Arduino, Raspberry Pi, ESP32.                                                                                                                                                                                                                                                                                                    |                                    |                  |                                                 |

|                                                                                                                                                                                                                          |                                 |               |            |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|---------------|------------|
| Interfacing sensors and actuators, Communication interfaces: UART, I2C, SPI. Power requirements and energy efficiency in IoT.                                                                                            |                                 |               |            |
| <b>Module-IV</b>                                                                                                                                                                                                         | <b>Embedded Systems for IoT</b> | <b>9 Hrs.</b> | <b>CO4</b> |
| Basics of Embedded Systems, Embedded C programming fundamentals, Firmware development for IoT devices, Introduction to RTOS concepts, Memory and resource constraints, Basic IoT system design using embedded platforms. |                                 |               |            |
| <b>Textbooks:</b>                                                                                                                                                                                                        |                                 |               |            |
| <b>T1.</b> N. Dhanjani, <i>Abusing the Internet of Things: Blackouts, Freakouts, and Stakeouts</i> , 1st ed. Mumbai: Shroff/O'Reilly, Sep. 2015.                                                                         |                                 |               |            |
| <b>T2.</b> S. K. Vasudevan, R. M. D. Sundaram, and A. S. Nagarajan, <i>Internet of Things</i> , 3rd ed. Noida, India: Wiley India, Jul. 2024.                                                                            |                                 |               |            |
| <b>Reference Books:</b>                                                                                                                                                                                                  |                                 |               |            |
| <b>R1.</b> Cuno Pfister, <i>Getting Started with the Internet of Things: Connecting Sensors and Microcontrollers to the Cloud (Make: Projects)</i> , 1st ed. Sebastopol, CA: O'Reilly Media/Maker Media, 2011.           |                                 |               |            |
| <b>R2.</b> F. daCosta and B. Henderson, <i>Rethinking the Internet of Things: A Scalable Approach to Connecting Everything</i> , 1st ed. New York, NY, USA: Apress, 2020.                                                |                                 |               |            |
| <b>R3.</b> R3. M. Banzi and M. Shiloh, <i>Make: Getting Started with Arduino</i> , 4th ed. Mumbai, India: Shroff Publishers/Make Community, LLC, 2024.                                                                   |                                 |               |            |
| <b>Relevant MOOCs Course (Course name and Weblink)</b>                                                                                                                                                                   |                                 |               |            |
| 4. Introduction To Internet Of Things, IIT Kharagpur, By Prof. Sudip Misra<br><a href="https://nptel.ac.in/courses/106105166">https://nptel.ac.in/courses/106105166</a>                                                  |                                 |               |            |
| 5. Introduction To Industry 4.0 And Industrial Internet Of Things, IIT Kharagpur, By Prof. Sudip Misra<br><a href="https://nptel.ac.in/courses/106105195">https://nptel.ac.in/courses/106105195</a>                      |                                 |               |            |
| 6. Design for internet of things, IISc Bangalore, By Prof. T V Prabhakar<br><a href="https://nptel.ac.in/courses/108108098">https://nptel.ac.in/courses/108108098</a>                                                    |                                 |               |            |
| <b>Relevant Topics for Self-study:</b>                                                                                                                                                                                   |                                 |               |            |
| ● Networking and Communication Technologies                                                                                                                                                                              |                                 |               |            |
| 2. Data Handling in IoT                                                                                                                                                                                                  |                                 |               |            |

| <b>Third Year B. Tech (T. Y B. Tech) AY (2026-27)</b><br><b>Information Technology (IT)</b><br><b>[2635HC31]: Internet of Things Lab (IoT Lab)</b>                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                               |                         |                           |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|---------------------------|
| <b>Semester</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>Credits</b>                                                                                                                                                                | <b>Teaching Scheme</b>  | <b>Examination Scheme</b> |
| <b>5</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>2</b>                                                                                                                                                                      | <b>P: 4 Hrs. / Week</b> | <b>ESE (TW): 25 Marks</b> |
| <b>Prerequisite: Students should have prior knowledge of</b><br>4. Foundational Knowledge of Computer Networking<br>5. Systems Thinking and Architecture Analysis                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                               |                         |                           |
| <b>Course Objectives: The objective of this course is to provide students with</b> <ul style="list-style-type: none"> <li>Describe the fundamentals of IoT hardware, embedded C, and cloud communication.</li> <li>Explain the working of Arduino/ESP32 with sensors and communication protocols.</li> <li>Demonstrate interfacing of sensors and data transmission to cloud platforms.</li> <li>Apply embedded C programming to implement basic IoT applications.</li> </ul> |                                                                                                                                                                               |                         |                           |
| <b>Course Outcomes: After completing this course, students will be able to</b><br><b>C01.</b> Identify IoT components and embedded system elements used in practical applications.<br><b>C02.</b> Explain the process of sensor interfacing and IoT communication using HTTP/MQTT.<br><b>C03.</b> Implement IoT applications using Arduino/ESP32 and embedded C programming.<br><b>C04.</b> Demonstrate data transmission and visualization using cloud platforms.            |                                                                                                                                                                               |                         |                           |
| <b>COURSE CONTENTS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                               |                         |                           |
| <b>Assign. No.</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>Description of Assignment</b>                                                                                                                                              | <b>CO</b>               |                           |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Temperature Sensor Interfacing - Interface LM35/DHT11 temperature sensor with Arduino/ESP32, Display temperature readings on Serial Monitor.                                  | C01                     |                           |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | IR Sensor Interfacing - Interface IR sensor (obstacle detection) with Arduino/ESP32, Turn ON/OFF LED based on object detection                                                | C01                     |                           |
| 3.                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Temperature Monitoring with LCD/Serial Output - Read temperature sensor data, Display output on Serial Monitor or LCD (16x2).                                                 | C02                     |                           |
| 4.                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Basic Embedded C Programs - Write Embedded C programs for: LED blinking, Button interfacing, Delay generation                                                                 | C02                     |                           |
| 5.                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Serial Communication using Embedded C - Send sensor data via serial communication, Read and display data on Serial Monitor                                                    | C03                     |                           |
| 6.                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Sending Data to Cloud using HTTP - Connect ESP32 to Wi-Fi, Send temperature data to cloud platform (e.g., ThingSpeak) using HTTP                                              | C03                     |                           |
| 7.                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Sending Data using MQTT Protocol - Configure MQTT broker (e.g., Mosquitto/Cloud MQTT), Publish temperature sensor data from ESP32, Subscribe and view data using MQTT client. | C04                     |                           |
| 8.                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Mini Integration Assignment - Combine: Temperature/IR sensor, Embedded C logic, Cloud communication (MQTT/HTTP), Example: Smart room monitoring system                        | C04                     |                           |

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|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Text Books:</b>                                                                |                                                                                                                                                                                                     |
| <b>T1</b>                                                                         | N. Dhanjani, <i>Abusing the Internet of Things: Blackouts, Freakouts, and Stakeouts</i> , 1st ed. Mumbai: Shroff/O'Reilly, Sep. 2015.                                                               |
| <b>T2</b>                                                                         | S. K. Vasudevan, R. M. D. Sundaram, and A. S. Nagarajan, <i>Internet of Things</i> , 3rd ed. Noida, India: Wiley India, Jul. 2024.                                                                  |
| <b>Reference Books:</b>                                                           |                                                                                                                                                                                                     |
| <b>R1.</b>                                                                        | Cuno Pfister, <i>Getting Started with the Internet of Things: Connecting Sensors and Microcontrollers to the Cloud (Make: Projects)</i> , 1st ed. Sebastopol, CA: O'Reilly Media/Maker Media, 2011. |
| <b>R2.</b>                                                                        | F. daCosta and B. Henderson, <i>Rethinking the Internet of Things: A Scalable Approach to Connecting Everything</i> , 1st ed. New York, NY, USA: Apress, 2020.                                      |
| <b>R3.</b>                                                                        | M. Banzi and M. Shiloh, <i>Make: Getting Started with Arduino</i> , 4th ed. Mumbai, India: Shroff Publishers/Make Community, LLC, 2024.                                                             |
| <b>Relevant MOOCs Course (Course name and Weblink):</b>                           |                                                                                                                                                                                                     |
| 3.                                                                                | Introduction to Embedded System Design by Prof. Dhananjay V. Gadre, Badri N. Subudhi<br><a href="https://nptel.ac.in/courses/108102169">https://nptel.ac.in/courses/108102169</a>                   |
| 4.                                                                                | Embedded System Design with ARM by By Prof Indranil SenGupta and Prof. Kamalika Datta<br><a href="https://nptel.ac.in/courses/106105193">https://nptel.ac.in/courses/106105193</a>                  |
| <b>Relevant Topics for Self-study:</b>                                            |                                                                                                                                                                                                     |
| Emerging IoT Standards and Protocols (e.g., 6LoWPAN, CoAP, NB-IoT, LoRaWAN).      |                                                                                                                                                                                                     |
| Role of Artificial Intelligence and Data Analytics in Enhancing IoT Applications. |                                                                                                                                                                                                     |

| <b>Third Year B. Tech (T. Y B. Tech) AY (2026-27)</b><br><b>Information Technology (IT)</b><br><b>[2636HC11]: IoT Communication and Cloud Technologies (ICCT)</b>                                                                                                                                                                                                                                                   |                                    |                         |                                                                      |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|-------------------------|----------------------------------------------------------------------|
| <b>Semester</b>                                                                                                                                                                                                                                                                                                                                                                                                     | <b>Credits</b>                     | <b>Teaching Scheme</b>  | <b>Examination Scheme</b>                                            |
| <b>6</b>                                                                                                                                                                                                                                                                                                                                                                                                            | <b>3</b>                           | <b>L: 3 Hrs. / Week</b> | <b>CIE: 20 Marks</b><br><b>ISE: 20 Marks</b><br><b>ESE: 60 Marks</b> |
| <b>Prerequisite: Students should have prior knowledge of</b> <ul style="list-style-type: none"> <li>Students should have knowledge of network protocols, embedded systems programming, control theory, and foundational cybersecurity principles.</li> </ul>                                                                                                                                                        |                                    |                         |                                                                      |
| <b>Course Objectives: The objective of this course is to provide students with</b> <ol style="list-style-type: none"> <li>To understand IoT communication protocols and networking concepts</li> <li>To study different layers and standards used in IoT communication</li> <li>To explore IoT cloud platforms and data handling</li> <li>To learn edge and fog computing for real-time IoT applications</li> </ol> |                                    |                         |                                                                      |
| <b>Course Outcomes: After completing this course, students will be able to</b> <p><b>C01.</b> Explain IoT networking architectures and communication protocols.</p> <p><b>C02.</b> Discuss various IoT Communication Protocols.</p> <p><b>C03.</b> Describe cloud platforms for IoT data storage and processing.</p> <p><b>C04.</b> Describe IoT solutions using edge and fog computing concepts.</p>               |                                    |                         |                                                                      |
| <b>COURSE CONTENTS</b>                                                                                                                                                                                                                                                                                                                                                                                              |                                    |                         |                                                                      |
| <b>Module-I</b>                                                                                                                                                                                                                                                                                                                                                                                                     | <b>IoT Networking Fundamentals</b> | <b>12 Hrs</b>           | <b>C01</b>                                                           |
| Overview of IoT Networking, IoT Architecture and Communication Stack, IP-based vs Non-IP-based communication, Addressing and identification (IPv6, 6LoWPAN basics), Wireless technologies: Wi-Fi, Bluetooth, Zigbee, LoRaWAN, Network topologies in IoT.                                                                                                                                                            |                                    |                         |                                                                      |
| <b>Module-II</b>                                                                                                                                                                                                                                                                                                                                                                                                    | <b>IoT Communication Protocols</b> | <b>9 Hrs</b>            | <b>C02</b>                                                           |
| Application layer protocols: MQTT, CoAP, HTTP, AMQP. Transport layer basics: TCP vs UDP. Publish-Subscribe vs Request-Response models. Message formats: JSON, XML, Protocol comparison and selection criteria, Security basics in IoT communication.                                                                                                                                                                |                                    |                         |                                                                      |
| <b>Module-III</b>                                                                                                                                                                                                                                                                                                                                                                                                   | <b>IoT Cloud Platforms</b>         | <b>9 Hrs</b>            | <b>C03</b>                                                           |

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| Introduction to Cloud Computing in IoT, IoT Cloud Architecture, Popular platforms: AWS IoT, Microsoft Azure IoT, Google Cloud IoT, Data ingestion, storage, and analytics, Dashboards and visualization tools, API integration and device management.                                                                                            |                               |              |            |
| <b>Module-IV</b>                                                                                                                                                                                                                                                                                                                                 | Edge and Fog Computing in IoT | <b>9 Hrs</b> | <b>C04</b> |
| Introduction to Edge and Fog Computing, Edge vs Cloud computing, Architecture of edge-enabled IoT systems, Real-time data processing at the edge, Use cases: Smart cities, industrial IoT, healthcare Challenges and future trends.                                                                                                              |                               |              |            |
| <b>Textbooks:</b>                                                                                                                                                                                                                                                                                                                                |                               |              |            |
| <b>T1:</b> O. Hersent, D. Boswarthick, and O. Elloumi, <i>The Internet of Things: Key Applications and Protocols</i> , 2nd ed., Hoboken, NJ, USA: Wiley, 2012.<br><b>T2:</b> D. Minoli, <i>Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications</i> , Hoboken, NJ, USA: Wiley, 2013.                    |                               |              |            |
| <b>Reference Books:</b>                                                                                                                                                                                                                                                                                                                          |                               |              |            |
| <b>R1.</b> A. Gilchrist, <i>IoT Security Issues</i> , 1st ed. Boston, MA, USA: De G Press, 2017.<br><b>R2.</b> S. Smith, <i>The Internet of Risky Things: Trusting the Devices That Surround Us</i> , 1st ed. Mumbai, India: Shroff Publishers/O'Reilly Media, 2017.                                                                             |                               |              |            |
| <b>Relevant MOOCs Course (Course name and Weblink)</b>                                                                                                                                                                                                                                                                                           |                               |              |            |
| 1. Introduction To Internet Of Things, IIT Kharagpur, By Prof. Sudip Misra<br><a href="https://nptel.ac.in/courses/106105166">https://nptel.ac.in/courses/106105166</a><br>2. Design for internet of things, IISc Bangalore, By Prof. T V Prabhakar<br><a href="https://nptel.ac.in/courses/108108098">https://nptel.ac.in/courses/108108098</a> |                               |              |            |
| <b>Relevant Topics for Self-study:</b>                                                                                                                                                                                                                                                                                                           |                               |              |            |
| Blockchain for IoT and CPS Security – exploring how distributed ledger technology enhances data integrity, authentication, and trust in IoT and CPS environments.                                                                                                                                                                                |                               |              |            |
| Machine Learning for Intrusion Detection and Threat Prediction – understanding AI-driven techniques to detect anomalies, prevent attacks, and secure SDN and IoT networks.                                                                                                                                                                       |                               |              |            |

| <b>Third Year B. Tech (T. Y B. Tech) AY (2026-27)</b><br><b>Information Technology (IT)</b><br><b>[2636HC31]: IoT Communication and Cloud Technologies Lab</b><br><b>(ICCTL)</b>                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                |                         |                           |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|---------------------------|
| <b>Semester</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>Credits</b>                                                                                                                                 | <b>Teaching Scheme</b>  | <b>Examination Scheme</b> |
| <b>6</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>2</b>                                                                                                                                       | <b>P: 4 Hrs. / Week</b> | <b>ESE (TW): 25 Marks</b> |
| <b>Prerequisite: Students should have knowledge of</b><br>6. Network protocols, embedded systems programming, control theory, and foundational cybersecurity principles.                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                |                         |                           |
| <b>Course Objectives: The objective of this course is to provide students with</b><br>14. Demonstrate the process of Wi-Fi connectivity and HTTP-based communication using ESP32.<br>15. Implement MQTT publish-subscribe communication for sensor data transmission<br>16. Demonstrate cloud integration and dashboard development for IoT data visualization. <ul style="list-style-type: none"> <li>• Implement edge processing and end-to-end IoT system integration</li> </ul>                                                                                                         |                                                                                                                                                |                         |                           |
| <b>Course Outcomes: After completing this course, students will be able to</b><br><b>C01.</b> Demonstrate how IoT hardware connects to a network and exchanges data with a web server using HTTP protocols.<br><b>C02.</b> Execute publishing and subscribing real-time sensor data using MQTT protocol with IoT hardware.<br><b>C03.</b> Implement sending sensor data to cloud platforms and visualizing real-time data using dashboards.<br><b>C04.</b> Demonstrate local data processing and develop a complete IoT system with sensor interfacing, communication, and cloud dashboard. |                                                                                                                                                |                         |                           |
| <b>COURSE CONTENTS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                |                         |                           |
| <b>Assign. No.</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>Description of Assignment</b>                                                                                                               | <b>CO</b>               |                           |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Wi-Fi Connectivity using ESP32 - Connect ESP32 to a Wi-Fi network, Display IP address on Serial Monitor                                        | C01                     |                           |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | HTTP Communication - send sensor (dummy/real) data from ESP32 to a web server using HTTP (GET/POST), Display response from server              | C01                     |                           |
| 3.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | MQTT Publish-Subscribe - Configure MQTT broker (e.g., Mosquitto/Cloud MQTT), Publish data from ESP32, Subscribe using MQTT client (PC/mobile). | C02                     |                           |
| 4.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Sensor Data Transmission using MQTT - Interface temperature sensor with ESP32, Send real-time sensor data to MQTT broker.                      | C02                     |                           |
| 5.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Cloud Integration using ThingSpeak - Send sensor data to ThingSpeak cloud platform, visualize data using graphs.                               | C03                     |                           |
| 6.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Cloud Dashboard Development - Create dashboard using IoT cloud (ThingSpeak/AWS IoT/Azure IoT), Display real-time sensor values.                | C03                     |                           |
| 7.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Edge Processing in IoT - Process sensor data locally on ESP32 (e.g., threshold                                                                 | C04                     |                           |

|                                                                                                                                                                                                              |                                                                                                                                                                                         |     |
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|                                                                                                                                                                                                              | detection), Send only filtered data to cloud.                                                                                                                                           |     |
| 8.                                                                                                                                                                                                           | Mini Project – End-to-End IoT System - Build complete system including: Sensor interfacing; Communication (MQTT/HTTP); Cloud dashboard, Example: Smart environment monitoring system.   | CO4 |
| <b>Text Books:</b>                                                                                                                                                                                           |                                                                                                                                                                                         |     |
| <b>T1</b>                                                                                                                                                                                                    | N. Godbole and S. Belapure, <i>Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives</i> , rev. ed. New Delhi, India: Wiley India, 2011 (Reprint 2025). |     |
| <b>T2</b>                                                                                                                                                                                                    | S. Li and L. D. Xu, <i>Securing the Internet of Things</i> , 1st ed. Cambridge, MA, USA: Syngress, 2017.                                                                                |     |
| <b>Reference Books:</b>                                                                                                                                                                                      |                                                                                                                                                                                         |     |
| <b>R1</b>                                                                                                                                                                                                    | A. Gilchrist, <i>IoT Security Issues</i> , 1st ed. Berlin, Germany: De Gruyter, 2017.                                                                                                   |     |
| <b>R2</b>                                                                                                                                                                                                    | S. Smith, <i>The Internet of Risky Things: Trusting the Devices That Surround Us</i> , 1st ed. Mumbai, India: Shroff Publishers/O'Reilly Media, 2017.                                   |     |
| <b>Relevant MOOCs Course (Course name and Weblink):</b>                                                                                                                                                      |                                                                                                                                                                                         |     |
| Foundation of Cloud IoT Edge ML, IIT Patna by Prof. Rajiv Misra<br><a href="https://nptel.ac.in/courses/106104242">https://nptel.ac.in/courses/106104242</a>                                                 |                                                                                                                                                                                         |     |
| <b>Relevant Topics for Self-study:</b>                                                                                                                                                                       |                                                                                                                                                                                         |     |
| Advanced Cryptography Applications in IoT and Wearables – exploring secure key management, homomorphic encryption, and digital signature schemes tailored for constrained IoT and mHealth devices.           |                                                                                                                                                                                         |     |
| AI-Driven Security and Predictive Analytics in Cyber-Physical Systems – studying machine learning techniques for anomaly detection, predictive maintenance, and risk mitigation in SDN and CPS environments. |                                                                                                                                                                                         |     |