

**South Indian Education Society's  
Graduate School of Technology**

NAAC 'A+', NBA Accredited (EXTC,CE,IT)

**Autonomous Institute Affiliated to  
University of Mumbai**



**Department of Computer Science and Engineering  
(Internet of Things and Cyber Security including Blockchain Technology)**

**Curriculum Structure for Undergraduate Academic Program in  
Department of Computer Science and Engineering  
(Internet of Things and Cyber Security including Blockchain Technology)  
and**

**Third Year Syllabus**

**Board of Studies  
Department of Computer Science and Engineering  
(Internet of Things and Cyber Security including Blockchain Technology)**

**Academic Council  
SIES Graduate School of Technology**

**Effective from: AY 2026-27**

## PREAMBLE

Dear Students, Faculty, and Stakeholders,

Greetings and congratulations to all the stakeholders of SIES Graduate School of Technology for getting autonomous status to the college from the year 2024-25. University Grant Commission vide letter No. F. 2- 10/2023(AC-Policy) dated 10 July 2024 conferred the autonomous status affiliated to University of Mumbai for a period of 10 years from the academic year 2024-2025 to 2033-2034 as per clause 7.5 of the UGC (Conferment of Autonomous Status Upon Colleges and Measures for Maintenance of Standards in Autonomous Colleges) Regulations, 2023. Autonomy will help design and implement curriculum which is more learner centric and robust to cater to the changing need of Society and Industry.

The Department of Computer Engineering SIES Graduate School of Technology, Nerul, Navi Mumbai, was established in 2002 and the current intake capacity is 180. One of the notable achievements is accreditation by the National Board of Accreditation (NBA) in 2011, 2021, 2024 which reflects our commitment in maintaining high standards of education and infrastructure.

We are delighted to announce the introduction of the newly designed curriculum for autonomy at SIES Graduate School of Technology. The newly designed curriculum for the Computer Engineering course at our autonomous institute is a reflection of our commitment to excellence, innovation, and inclusivity in higher education. Guided by the principles and objectives of the National Education Policy (NEP), this curriculum aims to create a robust framework that not only equips students with in-depth technical knowledge but also fosters holistic development, ethical values, and a lifelong passion for learning.

Curriculum emphases on flexibility, multidisciplinary education, and a learner-centric approach. It aims to develop well-rounded engineers with a strong foundation in core computer engineering skills, while integrating emerging technologies such as AI, machine learning, and cybersecurity. The curriculum also offers flexibility through electives, allowing students to tailor their education and foster interdisciplinary learning for a comprehensive skill set.

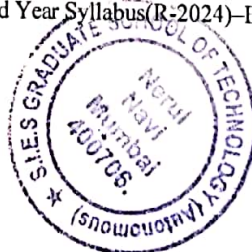
This curriculum is designed with strong industry collaboration to provide students with real-world experience through internships and projects, ensuring they are industry-ready upon graduation. We promote lifelong learning, ensuring that students remain curious, adaptable, and committed to growth throughout their careers. This curriculum empowers students to become innovative engineers, ethical leaders, and global citizens who will contribute to the advancement of technology and the betterment of society.

We would like to express our sincere gratitude to the faculty, alumni, students, industry experts, academicians, and stakeholders for their continuous support in strengthening our academics, making SIESGST one of the top engineering colleges in the nation and the premier choice for engineering aspirants.

  
Chairperson  
Board of Studies  
Computer Engineering  
SIES Graduate School of Technology

  
Chairperson  
Academic Council  
SIES Graduate School of Technology  
**SIES GRADUATE SCHOOL OF TECHNOLOGY (AUTONOMOUS)**  
Sri Chandrasekarendra Saraswathy Vidyapuram  
Navi Mumbai-400705

Curriculum Structure, Third Year Syllabus(R-2024)-B.E. in CSE(IoT&CSIBCT)



**Semester wise Credit distribution structure for Four Year UG Engineering**  
**Program - Computer Science and Engineering**  
**(Internet of Technology and Cyber Security including Blockchain Technology)**

| Semester                                                |                                                 | I         | II        | III       | IV        | V         | VI        | VII       | VIII      | Total Credits |
|---------------------------------------------------------|-------------------------------------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|---------------|
| Basic Science Course (BSC)                              | BSC/ESC                                         | 7         | 6         | --        | --        | --        | --        | --        | --        | 13            |
| Engineering Science Course (ESC)                        |                                                 | 9         | 10        | --        | --        | --        | --        | --        | --        | 19            |
| Programme Core Course (PCC)                             | Program Courses                                 | --        | --        | 17        | 11        | 12        | 10        | 04        | --        | 54            |
| Programme Elective Course (PEC)                         |                                                 | --        | --        | --        | --        | 03        | 04        | 07        | --        | 14            |
| Multidisciplinary Minor (MDM)                           | Multidisciplinary Courses                       | --        | --        | --        | 03        | 04        | 04        | 04        | --        | 15            |
| Open Elective (OE) Other than a particular program      |                                                 | --        | --        | --        | --        | --        | --        | 03        | 03        | 06            |
| Vocational and Skill Enhancement Course (VSEC)          | Skill Courses                                   | 01        | 01        | 02        | 02        | --        | 02        | --        | --        | 08            |
| Ability Enhancement Course (AEC -01, AEC-02)            | Humanities Social Science and Management (HSSM) | --        | 02        | --        | --        | 02        | --        | --        | --        | 04            |
| Entrepreneurship/Economics/Management Courses           |                                                 | --        | --        | 02        | 02        | --        | --        | --        | --        | 04            |
| Indian Knowledge System (IKS)                           |                                                 | --        | 02        | --        | --        | --        | --        | --        | --        | 02            |
| Value Education Course (VEC)                            |                                                 | --        | --        | --        | 02        | --        | --        | --        | --        | 02            |
| Research Methodology (RM)                               | Experiential Learning Courses                   | --        | --        | --        | --        | --        | --        | --        | 03        | 03            |
| Community Engagement Project (CEP) / Field Project (FP) |                                                 | --        | --        | 01        | 01        | --        | --        | --        | --        | 02            |
| Project                                                 |                                                 | --        | --        | --        | --        | 01        | 02        | 02        | 01        | 06            |
| Internship/On Job Training (OJT)                        |                                                 | --        | --        | --        | --        | --        | --        | --        | 12        | 12            |
| Co-curricular Courses (CC)                              | Liberal Learning Courses                        | 04        | --        | --        | --        | --        | --        | --        | --        | 04            |
| <b>Total Credits (Major)</b>                            |                                                 | <b>21</b> | <b>21</b> | <b>22</b> | <b>21</b> | <b>22</b> | <b>22</b> | <b>20</b> | <b>19</b> | <b>168</b>    |



Graduate School of  
Technology (Autonomous)  
RISE WITH EDUCATION

**SIES Graduate School of Technology**  
**Department of Computer Science and Engineering**  
**(Internet of Things and Cyber Security including Blockchain Technology)**  
**Bachelor of Engineering**

# **CURRICULUM STRUCTURE**

## **AND**

### **THIRD YEAR SYLLABUS**

**Computer Science and Engineering**

**(Internet of Technology and Cyber Security including Blockchain Technology)**

**Academic Year 2026-27**

| <b>Nomenclature of the courses in the curriculum</b> |                                              |
|------------------------------------------------------|----------------------------------------------|
| <b>Abbreviation</b>                                  | <b>Title</b>                                 |
| BSC                                                  | Basic Science Courses                        |
| ESC                                                  | Engineering Science Courses                  |
| PCC                                                  | Program Core Courses                         |
| MDM                                                  | Multidisciplinary Minor                      |
| PEC                                                  | Program Elective Course                      |
| OE                                                   | Open Elective                                |
| VSEC                                                 | Vocational and Skill Enhancement Course      |
| AEC                                                  | Ability Enhancement Course                   |
| IKS                                                  | Indian Knowledge System                      |
| VEC                                                  | Value Education Course                       |
| RM                                                   | Research Methodology                         |
| CEP/FP                                               | Community Engagement Project / Field Project |
| OJT                                                  | Internship/On Job Training                   |
| CC                                                   | Co-curricular Courses                        |
| ISE                                                  | In Semester Examination                      |
| MSE                                                  | Mid Semester Examination                     |
| ESE                                                  | End Semester Examination                     |
| CIAP                                                 | Continuous Internal Assessment Practical     |
| ESEP                                                 | End Semester Examination Practical           |

**Program Structure for First Year Engineering**  
**W.E.F. A.Y. 2024-25**  
**Semester I**

| Course Code         | Course Name                                             | Category | Teaching Scheme (Contact Hours) |                   |           | Credits Assigned |          |           |           |
|---------------------|---------------------------------------------------------|----------|---------------------------------|-------------------|-----------|------------------|----------|-----------|-----------|
|                     |                                                         |          | Theory                          | Pract             | Tut.      | Theory           | Pract    | Tut.      | Total     |
| FEC101              | Applied Mathematics -I                                  | BSC      | 3                               | --                | --        | 3                | --       | --        | 3         |
| FEC1021/<br>FEC1022 | Applied Physics/ Applied Chemistry <sup>@</sup>         | BSC      | 3                               | --                | --        | 3                | --       | --        | 3         |
| FEC103              | Basic Electrical & Electronics Engineering              | ESC      | 2                               | --                | --        | 2                | --       | --        | 2         |
| FEC104              | C-Programming                                           | ESC      | 2                               | --                | --        | 2                | --       | --        | 2         |
| FEC105              | Applied Mechanics and Robot Dynamics                    | ESC      | 2                               | --                | --        | 2                | --       | --        | 2         |
| FEL1011/<br>FEL1012 | Applied Physics Lab/ Applied Chemistry Lab <sup>@</sup> | BSC      | --                              | 1                 | --        | --               | 0.5      | --        | 0.5       |
| FEL102              | Basic Electrical & Electronics Engineering Lab          | ESC      | --                              | 2                 | --        | --               | 1        | --        | 1         |
| FEL103              | C-Programming Lab                                       | ESC      | --                              | 2                 | --        | --               | 1        | --        | 1         |
| FEL104              | Applied Mechanics and Robot Dynamics Lab                | ESC      | --                              | 2                 | --        | --               | 1        | --        | 1         |
| FEL105              | Engineering Workshop-I                                  | VSEC     | --                              | 2                 | --        | --               | 1        | --        | 1         |
| FEL106              | Health, Wellness and Mindfulness                        | CC       | --                              | 2 <sup>#</sup> +2 | --        | --               | 2        | --        | 2         |
| FEL107              | Induction Cum Universal Human Values                    | CC       | --                              | 5*                | --        | --               | 2.5      | --        | 2.5       |
| <b>Total</b>        |                                                         |          | <b>12</b>                       | <b>18</b>         | <b>--</b> | <b>12</b>        | <b>9</b> | <b>--</b> | <b>21</b> |

**Examination Scheme-FY Semester-I**

| Course Code         | Course Name                                             | Examination Scheme  |     |                   |                      |      |      |       |
|---------------------|---------------------------------------------------------|---------------------|-----|-------------------|----------------------|------|------|-------|
|                     |                                                         | Theory              |     |                   |                      | CIAP | ESEP | Total |
|                     |                                                         | Internal Assessment |     | ESE <sup>\$</sup> | Exam Duration (Hrs.) |      |      |       |
|                     |                                                         | ISE                 | MSE |                   |                      |      |      |       |
| FEC101              | Applied Mathematics -I                                  | 20                  | 20  | 60                | 3                    | --   | --   | 100   |
| FEC1021/<br>FEC1022 | Applied Physics/ Applied Chemistry <sup>@</sup>         | 20                  | 20  | 60                | 3                    | --   | --   | 100   |
| FEC103              | Basic Electrical & Electronics Engineering              | 15                  | 15  |                   | 2                    | --   | --   | 75    |
| FEC104              | C-Programming                                           | 15                  | 15  |                   | 2                    | --   | --   | 75    |
| FEC105              | Applied Mechanics and Robot Dynamics                    | 15                  | 15  |                   | 2                    | --   | --   | 75    |
| FEL1011/<br>FEL1012 | Applied Physics Lab/ Applied Chemistry Lab <sup>@</sup> | --                  | --  | --                | --                   | 25   | --   | 25    |
| FEL102              | Basic Electrical & Electronics Engineering Lab          | --                  | --  |                   | --                   | 25   | 25   | 50    |
| FEL103              | C-Programming Lab                                       | --                  | --  |                   | --                   | 25   | 25   | 50    |
| FEL104              | Applied Mechanics and Robot Dynamics Lab                | --                  | --  |                   | --                   | 25   | 25   | 50    |
| FEL105              | Engineering Workshop-I                                  | --                  | --  |                   | --                   | 25   | --   | 25    |
| FEL106              | Health, Wellness and Mindfulness                        | --                  | --  |                   | --                   | 25   | --   | 25    |
| FEL107              | Induction Cum Universal Human Values                    | --                  | --  |                   | --                   | 25   | --   | 25    |
| Total               |                                                         | 85                  | 85  | 255               |                      | 175  | 75   | 675   |

<sup>@</sup>Physics/Chemistry in one semester.

<sup>\$</sup> ESE of duration 3 hours are of 80 marks and scaled to 60. ESE duration of 2 hours are of 60 marks and scaled to 45. Theory 1 credit for 1 hour and practical 1 credit for 2 hours.

\*Indicates workload of a learner for UHV. Faculty Load: ½ hour per week per four groups # Two hours of practical class to be conducted for full class as demo/ discussion.

ISE: In Semester Examination: To be conducted in any of these forms - Assignment/ Quiz/ Presentation/ Class Test etc. of 20/15 marks. MSE: Mid Semester Examination: To be conducted as written examination for 20/15 marks of duration 1 Hr.

ESE: End Semester Examination

CIAP: Continuous Internal Assessment Practical. Term work will be assessed as Continuous Internal Assessment Practical (CIAP).

ESEP: End Semester Examination Practical. Oral/Practical Examination will be conducted as End Semester Examination Practical (ESEP).

**Program Structure for First Year Engineering**  
**W.E.F. A.Y. 2024-25**  
**Semester II**

| Course Code         | Course Name                                             | Category | Teaching Scheme (Contact Hours) |           |           | Credits Assigned |          |           |           |
|---------------------|---------------------------------------------------------|----------|---------------------------------|-----------|-----------|------------------|----------|-----------|-----------|
|                     |                                                         |          | Theory                          | Pract     | Tut.      | Theory           | Pract    | Tut.      | Total     |
| FEC201              | Applied Mathematics -II                                 | BSC      | 3                               | --        | --        | 3                | --       | --        | 3         |
| FEC201/<br>FEC202   | Applied Physics/ Applied Chemistry <sup>@</sup>         | BSC      | 3                               | --        | --        | 3                | --       | --        | 3         |
| FEC203              | Engineering Graphics                                    | ESC      | 2                               | --        | --        | 2                | --       | --        | 2         |
| FEC204              | Digital System Design                                   | ESC      | 3                               | --        | --        | 3                | --       | --        | 3         |
| FEC205              | Professional Communication Techniques                   | AEC      | 2                               | --        | --        | 2                | --       | --        | 2         |
| FEL2011/<br>FEL2012 | Applied Physics Lab/ Applied Chemistry Lab <sup>@</sup> | BSC      | --                              | 1         | --        | --               | 0.5      | --        | 0.5       |
| FEL202              | Engineering Graphics Lab                                | ESC      | --                              | 2         | --        | --               | 1        | --        | 1         |
| FEL203              | Digital System Design Lab                               | ESC      | --                              | 2         | --        | --               | 1        | --        | 1         |
| FEL204              | Professional Communication Techniques Lab               | AEC      | --                              | 1         | --        | --               | 0.5      | --        | 0.5       |
| FEL205              | Object Oriented Programming Methodology Lab             | ESC      | --                              | 2*+2      | --        | --               | 2        | --        | 2         |
| FEL206              | Engineering Workshop-II                                 | VSEC     | --                              | 2         | --        | --               | 1        | --        | 1         |
| FEL207              | Indian Knowledge System                                 | HSSM     | --                              | 2*+2      | --        | --               | 2        | --        | 2         |
| <b>Total</b>        |                                                         |          | <b>13</b>                       | <b>16</b> | <b>--</b> | <b>13</b>        | <b>8</b> | <b>--</b> | <b>21</b> |

**Examination Scheme-FY Semester-II**

| Course Code         | Course Name                                             | Examination Scheme  |     |                   |                      |      |      |       |
|---------------------|---------------------------------------------------------|---------------------|-----|-------------------|----------------------|------|------|-------|
|                     |                                                         | Theory              |     |                   |                      | CIAP | ESEP | Total |
|                     |                                                         | Internal Assessment |     | ESE <sup>\$</sup> | Exam Duration (Hrs.) |      |      |       |
|                     |                                                         | ISE                 | MSE |                   |                      |      |      |       |
| FEC201              | Applied Mathematics -II                                 | 20                  | 20  | 60                | 03                   | --   | --   | 100   |
| FEC2021/<br>FEC2022 | Applied Physics/ Applied Chemistry <sup>@</sup>         | 20                  | 20  | 60                | 03                   | --   | --   | 100   |
| FEC203              | Engineering Graphics                                    | 15                  | 15  | 45                | 03                   | --   | --   | 75    |
| FEC204              | Digital System Design                                   | 20                  | 20  | 60                | 03                   | --   | --   | 100   |
| FEC205              | Professional Communication Techniques                   | 15                  | 15  | 45                | 02                   | --   | --   | 75    |
| FEL2011/<br>FEL2012 | Applied Physics Lab/ Applied Chemistry Lab <sup>@</sup> | --                  | --  | --                | --                   | 25   | --   | 25    |
|                     | Engineering Graphics Lab                                | --                  | --  | --                | --                   | 25   | 25   |       |
| FEL203              | Digital System Design Lab                               | --                  | --  | --                | --                   | 25   | 25   | 50    |
| FEL204              | Professional Communication Techniques Lab               | --                  | --  | --                | --                   | 25   | --   | 25    |
| FEL205              | Object Oriented Programming Methodology Lab             | --                  | --  | --                | --                   | 25   | 25   | 50    |
|                     | Engineering Workshop-II                                 | --                  | --  |                   |                      | 25   |      |       |
| FEL207              | Indian Knowledge System                                 | --                  | --  | --                | --                   | 25   | --   | 25    |
| Total               |                                                         | 90                  | 90  | 270               | --                   | 175  | 75   | 700   |

<sup>@</sup>Physics/Chemistry in one semester.

\* Two hours of practical class to be conducted for full class as demo/ discussion.

# Course evaluation is an activity based which may be an individual or group of students.

\$ ESE of duration 3 hours are of 80 marks and scaled to 60. ESE duration of 2 hours are of 60 marks and scaled to 45. Theory 1 credit for 1 hour and practical 1 credit for 2 hours.

ISE: In Semester Examination: To be conducted in any of these forms - Assignment/ Quiz/ Presentation/ Class Test etc. of 20/15 marks. MSE: Mid Semester Examination: To be conducted as written examination for 20/15 marks of duration 1 Hr.

ESE: End Semester Examination

CIAP: Continuous Internal Assessment Practical. Term work will be assessed as Continuous Internal Assessment Practical (CIAP).

ESEP: End Semester Examination Practical. Oral/Practical Examination will be conducted as End Semester Examination Practical (ESEP).

**Program Structure for Second Year**  
**W.E.F. A.Y. 2025-26**  
**Semester III**

| Course Code  | Course Name                                | Category | Teaching Scheme (Contact Hours) |                |           | Credits Assigned |          |           |           |
|--------------|--------------------------------------------|----------|---------------------------------|----------------|-----------|------------------|----------|-----------|-----------|
|              |                                            |          | Theory                          | Pract.         | Tut.      | Theory           | Pract.   | Tut.      | Total     |
| CSEC301      | Applied Mathematics III                    | PCC      | 3                               | --             | --        | 3                | --       | --        | 3         |
| CSEC302      | Data Structures and Algorithms             | PCC      | 3                               | --             | --        | 3                | --       | --        | 3         |
| CSEC303      | Discrete Structure and Automata Theory     | PCC      | 3                               | --             | --        | 3                | --       | --        | 3         |
| CSEC304      | Database Management System                 | PCC      | 3                               | --             | --        | 3                | --       | --        | 3         |
| CSEC305      | Computer Organization and Architecture     | PCC      | 2                               | --             | --        | 2                | --       | --        | 2         |
| CSEC306      | Engineering Economics                      | HSSM     | 2                               | --             | --        | 2                | --       | --        | 2         |
| CSEL301      | Data Structures and Algorithms Lab         | PCC      | --                              | 2              | --        | --               | 1        | --        | 1         |
| CSEL302      | Database Management System Lab             | PCC      | --                              | 2              | --        | --               | 1        | --        | 1         |
| CSEL303      | Computer Organization and Architecture Lab | PCC      | --                              | 2              | --        | --               | 1        | --        | 1         |
| CSEL304      | Skill Lab - Python Programming             | VSEC     | --                              | 2*+2           | --        | --               | 2        | --        | 2         |
| CSEM301      | Mini Project 1A                            | CEP      | --                              | 2 <sup>#</sup> | --        | --               | 1        | --        | 1         |
| <b>Total</b> |                                            |          | <b>16</b>                       | <b>12</b>      | <b>--</b> | <b>16</b>        | <b>6</b> | <b>--</b> | <b>22</b> |

**Examination Scheme - CSE (IoT&CSIBCT) Semester-III**

| Course Code | Course Name                                | Examination Scheme  |     |                  |                      |      |      |       |
|-------------|--------------------------------------------|---------------------|-----|------------------|----------------------|------|------|-------|
|             |                                            | Theory              |     |                  |                      | CIAP | ESEP | Total |
|             |                                            | Internal Assessment |     | ESE <sup>s</sup> | Exam Duration (Hrs.) |      |      |       |
|             |                                            | ISE                 | MSE |                  |                      |      |      |       |
| CSEC301     | Applied Mathematics III                    | 20                  | 20  | 60               | 3                    | --   | --   | 100   |
| CSEC302     | Data Structures & Algorithms               | 20                  | 20  | 60               | 3                    | --   | --   | 100   |
| CSEC303     | Discrete Structure and Automata Theory     | 20                  | 20  | 60               | 3                    | --   | --   | 100   |
| CSEC304     | Database Management System                 | 20                  | 20  | 60               | 3                    | --   | --   | 100   |
| CSEC305     | Computer Organization and Architecture     | 15                  | 15  | 45               | 2                    | --   | --   | 75    |
| CSEC306     | Engineering Economics                      | 50                  |     | --               | --                   | --   | --   | 50    |
| CSEL301     | Data Structures & Algorithms Lab           | --                  | --  | --               | --                   | 25   | 25   | 50    |
| CSEL302     | Database Management System Lab             | --                  | --  | --               | --                   | 25   | 25   | 50    |
| CSEL303     | Computer Organization and Architecture Lab | --                  | --  | --               | --                   | 25   | --   | 25    |
| CSEL304     | Skill Lab - Python Programming             | --                  | --  | --               | --                   | 25   | 25   | 50    |
| CSEM301     | Mini Project 1A                            | --                  | --  | --               | --                   | 25   | 25   | 50    |
| Total       |                                            | 145                 | 95  | 285              | --                   | 125  | 100  | 750   |

\* Two hours of practical class to be conducted for full class as demo/ discussion.

# Indicates workload of a learner (Not faculty) for Mini Project 1A. Faculty Load: ½ hour per week per four groups

\$ ESE of duration 3 hours are of 80 marks and scaled to 60. ESE duration of 2 hours are of 60 marks and scaled to 45.

**Program Structure for Second Year**  
**W.E.F. A.Y. 2025-26**  
**Semester IV**

| Course Code  | Course Name                     | Category   | Teaching Scheme (Contact Hours) |                |           | Credits Assigned |          |           |           |
|--------------|---------------------------------|------------|---------------------------------|----------------|-----------|------------------|----------|-----------|-----------|
|              |                                 |            | Theory                          | Pract.         | Tut.      | Theory           | Pract.   | Tut.      | Total     |
| CSEC401      | Applied Mathematics IV          | PCC        | 3                               | --             | --        | 3                | --       | --        | 3         |
| CSEC402      | Operating System                | PCC        | 3                               |                | --        | 3                | --       | --        | 3         |
| CSEC403      | Computer Network                | PCC        | 3                               |                | --        | 3                | --       | --        | 3         |
| CSEC404      | Critical Thinking and Design    | HSSM       | 2                               | --             | --        | 2                | --       | --        | 2         |
| MDMC40X1     | Multidisciplinary Minor (MDM-I) | MDM        | 3                               | --             | --        | 3                | --       | --        | 3         |
| CSEL401      | Operating System Lab            | PCC        | --                              | 2              | --        | --               | 1        | --        | 1         |
| CSEL402      | Computer Network Lab            | PCC        | --                              | 2              | --        | --               | 1        | --        | 1         |
| CSEL403      | Skill Lab - Web Technology      | VSEC       | --                              | 2*+2           | --        | --               | 2        | --        | 2         |
| CSEL404      | Value Education Course (UHV)    | HSSM (VEC) | --                              | 4              | --        | --               | 2        | --        | 2         |
| CSEM401      | Mini Project 1B                 | CEP        | --                              | 2 <sup>#</sup> | --        | --               | 1        | --        | 1         |
| <b>Total</b> |                                 |            | <b>14</b>                       | <b>14</b>      | <b>--</b> | <b>14</b>        | <b>7</b> | <b>--</b> | <b>21</b> |

**Examination Scheme - CSE (IoT&CSIBCT) Semester-IV**

| Course Code | Course Name                     | Examination Scheme  |     |                   |                      |      |      |       |
|-------------|---------------------------------|---------------------|-----|-------------------|----------------------|------|------|-------|
|             |                                 | Theory              |     |                   |                      | CIAP | ESEP | Total |
|             |                                 | Internal Assessment |     | ESE <sup>\$</sup> | Exam Duration (Hrs.) |      |      |       |
|             |                                 | ISE                 | MSE |                   |                      |      |      |       |
| CSEC401     | Applied Mathematics IV          | 20                  | 20  | 60                | 3                    | --   | --   | 100   |
| CSEC402     | Operating System                | 20                  | 20  | 60                | 3                    | --   | --   | 100   |
| CSEC403     | Computer Network                | 20                  | 20  | 60                | 3                    | --   | --   | 100   |
| CSEC404     | Critical Thinking and Design    | 15                  | 15  | 45                | 2                    | --   | --   | 75    |
| MDMC40X1    | Multidisciplinary Minor (MDM-I) | 20                  | 20  | 60                | 3                    | --   | --   | 100   |
| CSEL401     | Operating System Lab            | --                  | --  | --                | --                   | 25   | 25   | 50    |
| CSEL402     | Computer Network Lab            | --                  | --  | --                | --                   | 25   | 25   | 50    |
| CSEL403     | Skill Lab - Web Technology      | --                  | --  | --                | --                   | 25   | 25   | 50    |
| CSEL404     | Value Education Course (UHV)    | --                  | --  | --                | --                   | 50   | --   | 50    |
| CSEM401     | Mini Project 1B                 |                     |     |                   |                      | 25   | 25   | 50    |
| Total       |                                 | 95                  | 95  | 285               | --                   | 150  | 100  | 725   |

\* Two hours of practical class to be conducted for full class as demo/ discussion.

# Indicates workload of a learner (Not faculty) for Mini Project 1B. Faculty Load: ½ hour per week per four groups

\$ ESE of duration 3 hours are of 80 marks and scaled to 60. ESE duration of 2 hours are of 60 marks and scaled to 45.

**Program Structure for Third Year**  
**W.E.F. A.Y. 2026-27**  
**Semester V**

| Course Code  | Course Name                                     | Category   | Teaching Scheme (Contact Hours) |                    |           | Credits Assigned |                    |           |           |
|--------------|-------------------------------------------------|------------|---------------------------------|--------------------|-----------|------------------|--------------------|-----------|-----------|
|              |                                                 |            | Theory                          | Pract              | Tut.      | Theory           | Pract.             | Tut.      | Total     |
| CSEC501      | Cryptography and Network Security               | PCC        | 3                               | --                 | --        | 3                | --                 | --        | 3         |
| CSEC502      | Software Engineering and Project Management     | PCC        | 3                               | --                 | --        | 3                | --                 | --        | 3         |
| CSEC503      | Introduction to Blockchain Technology           | PCC        | 3                               | --                 | --        | 3                | --                 | --        | 3         |
| MDMC50X2     | Multidisciplinary Minor (MDM-II)                | MDM        | 3                               | --                 | --        | 3                | --                 | --        | 3         |
| CSEPEC501X   | Program Elective-I                              | PEC        | 3                               | --                 | --        | 3                | --                 | --        | 3         |
| CSEL501      | Cryptography and Network Security Lab           | PCC        | --                              | 2                  | --        | --               | 1                  | --        | 1         |
| CSEL502      | Software Engineering and Project Management Lab | PCC        | --                              | 2                  | --        | --               | 1                  | --        | 1         |
| CSEL503      | Blockchain Technology Lab                       | PCC        | --                              | 2                  | --        | --               | 1                  | --        | 1         |
| CSEL504      | Interpersonal and Career Skills                 | HSSM (AEC) | --                              | 2*+2               | --        | --               | 2                  | --        | 2         |
| MDML50X1     | Multidisciplinary Minor (MDM-II) Lab/Tut        | MDM        | --                              | 2 <sup>&amp;</sup> | --        | --               | 1 <sup>&amp;</sup> | --        | 1         |
| CSEM501      | Mini Project 2                                  | MP         | --                              | 2 <sup>#</sup>     | --        | --               | 1                  | --        | 1         |
| <b>Total</b> |                                                 |            | <b>15</b>                       | <b>14</b>          | <b>--</b> | <b>15</b>        | <b>7</b>           | <b>--</b> | <b>22</b> |

**Examination Scheme - CSE (IoT&CSIBCT) Semester-V**

| Course Code | Course Name                                     | Examination Scheme  |     |                   |                      |      |      |       |
|-------------|-------------------------------------------------|---------------------|-----|-------------------|----------------------|------|------|-------|
|             |                                                 | Theory              |     |                   |                      | CIAP | ESEP | Total |
|             |                                                 | Internal Assessment |     | ESE <sup>\$</sup> | Exam Duration (Hrs.) |      |      |       |
|             |                                                 |                     |     |                   |                      |      |      |       |
| CSEC501     | Cryptography and Network Security               | 20                  | 20  | 60                | 3                    | --   | --   | 100   |
| CSEC502     | Software Engineering and Project Management     | 20                  | 20  | 60                | 3                    | --   | --   | 100   |
| CSEC503     | Introduction to Blockchain Technology           | 20                  | 20  | 60                | 3                    | --   | --   | 100   |
| MDMC50X2    | Multidisciplinary Minor (MDM-II)                | 20                  | 20  | 60                | 3                    | --   | --   | 100   |
| CSEPEC501X  | Program Elective-I                              | 20                  | 20  | 60                | 3                    | --   | --   | 100   |
| CSEL501     | Cryptography and Network Security Lab           | --                  | --  | --                | --                   | 25   | 25   | 50    |
| CSEL502     | Software Engineering and Project Management Lab | --                  | --  | --                | --                   | 25   | --   | 25    |
| CSEL503     | Blockchain Technology Lab                       | --                  | --  | --                | --                   | 25   | 25   | 50    |
| CSEL504     | Interpersonal and Career Skills                 | --                  | --  | --                | --                   | 50   | --   | 50    |
| MDML50X1    | Multidisciplinary Minor ((MDM-II) Lab/Tut       | --                  | --  | --                | --                   | 25   | --   | 25    |
| CSEM501     | Mini Project 2                                  | --                  | --  | --                | --                   | 25   | 25   | 50    |
| Total       |                                                 | 100                 | 100 | 300               | --                   | 175  | 75   | 750   |

\* Two hours of practical class to be conducted for full class as demo/ discussion.

# indicates workload of a learner (Not faculty) for Mini Project 2A. Faculty Load: ½ hour per week per four groups

\$ ESE of duration 3 hours are of 80 marks and scaled to 60. ESE duration of 2 hours are of 60 marks and scaled to 45.

& Tuts only for management MDM (MDMC5062)

**Program Elective – I**

| <b>Technology Bucket</b>                        |                                                  |                                        |                                                    |
|-------------------------------------------------|--------------------------------------------------|----------------------------------------|----------------------------------------------------|
| <b>IoT</b>                                      | <b>Blockchain Technology</b>                     | <b>Cyber Security</b>                  | <b>Data Science</b>                                |
| <b>CSEPEC5011:</b><br>IoT Systems<br>Processors | <b>CSEPEC5012:</b><br>Cryptocurrency and Bitcoin | <b>CSEPEC5013:</b><br>Malware Analysis | <b>CSEPEC5014:</b><br>Data ware housing and Mining |

**Program Structure for Third Year**  
**W.E.F. A.Y. 2026-27**  
**Semester VI**

| Course Code  | Course Name                                  | Category | Teaching Scheme (Contact Hours) |                    |           | Credits Assigned |                    |           |           |
|--------------|----------------------------------------------|----------|---------------------------------|--------------------|-----------|------------------|--------------------|-----------|-----------|
|              |                                              |          | Theory                          | Pract.             | Tut.      | Theory           | Pract.             | Tut.      | Total     |
| CSEC601      | IoT Architecture and Protocols               | PCC      | 3                               | --                 | --        | 3                | --                 | --        | 3         |
| CSEC602      | Advance Blockchain Technology                | PCC      | 2                               | --                 | --        | 2                | --                 | --        | 2         |
| CSEC603      | Digital Forensics and Ethical Hacking        | PCC      | 3                               | --                 | --        | 3                | --                 | --        | 3         |
| MDMC60X3     | Multidisciplinary Minor (MDM-III)            | MDM      | 3                               | --                 | --        | 3                | --                 | --        | 3         |
| CSEPEC601X   | Program Elective-II                          | PEC      | 3                               | --                 | --        | 3                | --                 | --        | 3         |
| CSEL601      | IoT Architecture and Protocols Lab           | PCC      | --                              | 2                  | --        | --               | 1                  | --        | 1         |
| CSEL602      | Digital Forensics and Ethical Hacking Lab    | PCC      | --                              | 2                  | --        | --               | 1                  | --        | 1         |
| CSEL603      | Skill Lab-Cloud Computing and Cloud Security | VSEC     | --                              | 2*+2               | --        | --               | 2                  | --        | 2         |
| MDML60X2     | Multidisciplinary Minor (MDM-III) Lab/Tut    | MDM      | --                              | 2 <sup>&amp;</sup> | --        | --               | 1 <sup>&amp;</sup> | --        | 1         |
| CSEPEL601X   | Program Elective-II Lab                      | PEC      | --                              | 2                  | --        | --               | 1                  | --        | 1         |
| CSEM601      | Major Project I                              | MP       | --                              | 4 <sup>#</sup>     | --        | --               | 2                  | --        | 2         |
| <b>Total</b> |                                              |          | <b>14</b>                       | <b>16</b>          | <b>--</b> | <b>14</b>        | <b>8</b>           | <b>--</b> | <b>22</b> |

**Examination Scheme - CSE (IoT&CSIBCT) Semester-VI**

| Course Code | Course Name                                   | Examination Scheme  |     |                  |                      |      |      |       |
|-------------|-----------------------------------------------|---------------------|-----|------------------|----------------------|------|------|-------|
|             |                                               | Theory              |     |                  |                      | CIAP | ESEP | Total |
|             |                                               | Internal Assessment |     | ESE <sup>s</sup> | Exam Duration (Hrs.) |      |      |       |
|             |                                               | ISE                 | MSE |                  |                      |      |      |       |
| CSEC601     | IoT Architecture and Protocols                | 20                  | 20  | 60               | 3                    | --   | --   | 100   |
| CSEC602     | Advance Blockchain Technology                 | 15                  | 15  | 45               | 2                    | --   | --   | 75    |
| CSEC603     | Digital Forensics and Ethical Hacking         | 20                  | 20  | 60               | 3                    | --   | --   | 100   |
| MDMC60X3    | Multidisciplinary Minor (MDM-III)             | 20                  | 20  | 60               | 3                    | --   | --   | 100   |
| CSEPEC601X  | Program Elective-II                           | 20                  | 20  | 60               | 3                    | --   | --   | 100   |
| CSEL601     | IoT Architecture and Protocols Lab            | --                  | --  | --               | --                   | 25   | --   | 25    |
| CSEL602     | Digital Forensics and Ethical Hacking Lab     | --                  | --  | --               | --                   | 25   | 25   | 50    |
| CSEL603     | Skill Lab -Cloud Computing and Cloud Security | --                  | --  | --               | --                   | 25   | 25   | 50    |
| MDML60X2    | Multidisciplinary Minor (MDM-III) Lab/Tut     | --                  | --  | --               | --                   | 25   | --   | 25    |
| CSEPEL601X  | Program Elective-II Lab                       | --                  | --  | --               | --                   | 25   | --   | 25    |
| CSEM601     | Major Project I                               | --                  | --  | --               | --                   | 25   | 25   | 50    |
| Total       |                                               | 95                  | 95  | 285              | --                   | 150  | 75   | 700   |

\* Two hours of practical class to be conducted for full class as demo/ discussion.

#Indicates workload of a learner (Not faculty) for Major project I Faculty Load: ½ hour per week per four groups

\$ ESE of duration 3 hours are of 80 marks and scaled to 60. ESE duration of 2 hours are of 60 marks and scaled to 45.

& Tuts only for management MDM (MDMC6063)

**Program Elective – II**

| <b>Technology Bucket</b>                    |                                        |                                                                                     |                                                               |
|---------------------------------------------|----------------------------------------|-------------------------------------------------------------------------------------|---------------------------------------------------------------|
| <b>IoT</b>                                  | <b>Blockchain Technology</b>           | <b>Cyber Security</b>                                                               | <b>Data Science</b>                                           |
| <b>CSEPEC6011:</b><br>Industrial IoT        | <b>CSEPEC6012:</b><br>NFT and DeFi     | <b>CSEPEC6013:</b><br>Vulnerability<br>Assessment and<br>Penetration Testing        | <b>CSEPEC6014:</b><br>Data Analytics and Visualization        |
| <b>CSEPEL6011:</b><br>Industrial IoT<br>Lab | <b>CSEPEL6012:</b><br>NFT and DeFi Lab | <b>CSEPEL6013:</b><br>Vulnerability<br>Assessment and<br>Penetration Testing<br>Lab | <b>CSEPEL6014:</b><br>Data Analytics and Visualization<br>Lab |

**Program Structure for Final Year**

**W.E.F. A.Y. 2027-28**

**Semester VII**

| Course Code  | Course Name                              | Category | Teaching Scheme (Contact Hours) |                    |           | Credits Assigned |                    |           |           |
|--------------|------------------------------------------|----------|---------------------------------|--------------------|-----------|------------------|--------------------|-----------|-----------|
|              |                                          |          | Theory                          | Pract.             | Tut.      | Theory           | Pract.             | Tut.      | Total     |
| CSEC701      | Edge / Fog Computing                     | PCC      | 3                               | --                 | --        | 3                | --                 | --        | 3         |
| MDMC70X4     | Multidisciplinary Minor (MDM-IV)         | MDM      | 3                               | --                 | --        | 3                | --                 | --        | 3         |
| CSEPEC701X   | Program Elective –III                    | PEC      | 3                               | --                 | --        | 3                | --                 | --        | 3         |
| CSEPEC702X   | Program Elective –IV                     | PEC      | 3                               | --                 | --        | 3                | --                 | --        | 3         |
| OEC701X      | Open Elective-I                          | OE       | 3                               | --                 | --        | 3                | --                 | --        | 3         |
| CSEL701      | Edge / Fog Computing Lab                 | PCC      | --                              | 2                  | --        | --               | 1                  | --        | 1         |
| MDML70X3     | Multidisciplinary Minor (MDM-IV) Lab/Tut | MDM      | --                              | 2 <sup>&amp;</sup> | --        | --               | 1 <sup>&amp;</sup> | --        | 1         |
| CSEPEL701X   | Program Elective –III Lab                | PEC      | --                              | 2                  | --        | --               | 1                  | --        | 1         |
| CSEP701      | Major project II                         | MJP      | --                              | 4 <sup>#</sup>     | --        | --               | 2                  | --        | 2         |
| <b>Total</b> |                                          |          | <b>15</b>                       | <b>10</b>          | <b>--</b> | <b>15</b>        | <b>5</b>           | <b>--</b> | <b>20</b> |

**Examination Scheme - CSE (IoT&CSIBCT) Semester-VII**

| Course Code | Course Name                              | Examination Scheme  |     |                  |                      |      |      |       |
|-------------|------------------------------------------|---------------------|-----|------------------|----------------------|------|------|-------|
|             |                                          | Theory              |     |                  |                      | CIAP | ESEP | Total |
|             |                                          | Internal Assessment |     | ESE <sup>s</sup> | Exam Duration (Hrs.) |      |      |       |
|             |                                          | ISE                 | MSE |                  |                      |      |      |       |
| CSEC701     | Edge / Fog Computing                     | 20                  | 20  | 60               | 3                    | --   | --   | 100   |
| MDMC70X4    | Multidisciplinary Minor (MDM-IV)         | 20                  | 20  | 60               | 3                    | --   | --   | 100   |
| CSEPEC701X  | Program Elective –III                    | 20                  | 20  | 60               | 3                    | --   | --   | 100   |
| CSEPEC702X  | Program Elective –IV                     | 20                  | 20  | 60               | 3                    | --   | --   | 100   |
| OEC701X     | Open Elective-I                          | 20                  | 20  | 60               | 3                    | --   | --   | 100   |
| CSEL701     | Edge / Fog Computing Lab                 | --                  | --  | --               | --                   | 25   | 25   | 50    |
| MDML70X3    | Multidisciplinary Minor (MDM-IV) Lab/Tut | --                  | --  | --               | --                   | 25   | --   | 25    |
| CSEPEL701X  | Program Elective –III Lab                | --                  | --  | --               | --                   | 25   | 25   | 50    |
| CSEP701     | Major Project II                         | --                  | --  | --               | --                   | 25   | 25   | 50    |
| Total       |                                          | 100                 | 100 | 300              | --                   | 100  | 75   | 675   |

# indicates workload of Learner (Not faculty), for Major Project II Project Guide Load = ½ hour per week per project group

\$ ESE of duration 3 hours are of 80 marks and scaled to 60. ESE duration of 2 hours are of 60 marks and scaled to 45.

& Tuts only for management MDM (MDMC7064)

**Program Elective-III**

| <b>Technology Bucket</b>                   |                                                                    |                                                   |                                         |
|--------------------------------------------|--------------------------------------------------------------------|---------------------------------------------------|-----------------------------------------|
| <b>IoT</b>                                 | <b>Blockchain Technology</b>                                       | <b>Cyber Security</b>                             | <b>Data Science</b>                     |
| <b>CSEPEC7011:</b><br>IoT for Smart Cities | <b>CSEPEC7012:</b><br>Design A Blockchain Application Architecture | <b>CSEPEC7013:</b><br>Security in Cloud Computing | <b>CSEPEC7014:</b><br>Big Data Analysis |

**Program Elective-IV**

| <b>Technology Bucket</b>                         |                                            |                                           |                                              |
|--------------------------------------------------|--------------------------------------------|-------------------------------------------|----------------------------------------------|
| <b>IoT</b>                                       | <b>Blockchain Technology</b>               | <b>Cyber Security</b>                     | <b>Data Science</b>                          |
| <b>CSEPEC7021:</b><br>High Performance Computing | <b>CSEPEC7022:</b><br>Blockchain Ecosystem | <b>CSEPEC7023:</b><br>Writing Secure Code | <b>CSEPEC7024:</b><br>Social Media Analytics |

**Open Elective-I**

| <b>Course Code</b> | <b>Course Name</b>                          |
|--------------------|---------------------------------------------|
| OEC7011            | Project Management                          |
| OEC7012            | Finance Management                          |
| OEC7013            | Management Information System               |
| OEC7014            | Entrepreneurship Development and Management |
| OEC7015            | Operation Research                          |
| OEC7016            | Disaster Management and Mitigation Measures |
| OEC7017            | Product Design                              |

**Program Structure for Fourth Year**

**W.E.F. A.Y. 2027-28**

**Semester VIII**

| Course Code  | Course Name                   | Category   | Teaching Scheme<br>(Contact Hours) |                |      | Credits Assigned |           |           |           |
|--------------|-------------------------------|------------|------------------------------------|----------------|------|------------------|-----------|-----------|-----------|
|              |                               |            | Theory                             | Pract.         | Tut. | Theory           | Pract.    | Tut.      | Total     |
| CSEC801      | Research Methodology          | RM         | 3                                  | --             | --   | 3                | --        | --        | 3         |
| OEC801X      | Institute Elective-II         | OE         | 3                                  | --             | --   | 3                | --        | --        | 3         |
| CSEP801      | Major Project III             | MJP        | --                                 | 2 <sup>#</sup> | --   | --               | 1         | --        | 1         |
| CSEINT801    | Internship/ Project /Research | Internship | --                                 | --             | --   | --               | 12        | --        | 12        |
| <b>Total</b> |                               |            | <b>6</b>                           | <b>2</b>       |      | <b>6</b>         | <b>13</b> | <b>--</b> | <b>19</b> |

**Examination Scheme – CSE (IoT&CSIBCT) Semester-VIII**

| Course Code | Course Name                   | Examination Scheme  |     |                   |                      |      |      |       |
|-------------|-------------------------------|---------------------|-----|-------------------|----------------------|------|------|-------|
|             |                               | Theory              |     |                   |                      | CIAP | ESEP | Total |
|             |                               | Internal Assessment |     | ESE <sup>\$</sup> | Exam Duration (Hrs.) |      |      |       |
|             |                               | ISE                 | MSE |                   |                      |      |      |       |
| CSEC801     | Research Methodology          | 20                  | 20  | 60                | 3                    | --   | --   | 100   |
| OEC801X     | Open Elective-II              | 20                  | 20  | 60                | 3                    | --   | --   | 100   |
| CSEP801     | Major Project III             | --                  | --  | --                | --                   | 100  | 50   | 150   |
| CSEINT801   | Internship/ Project /Research | --                  | --  | --                | --                   | 200  | --   | 200   |
| Total       |                               | 40                  | 40  | 120               | --                   | 300  | 50   | 550   |

# indicates workload of Learner (Not faculty), for Major

Project Guide Load = ½ hour per week per project group

\$ ESE of duration 3 hours are of 80 marks and scaled to 60. ESE duration of 2 hours is of 60 marks and scaled to 45.



Graduate School of  
Technology (Autonomous)

**SIES Graduate School of Technology**  
**Department of Computer Science and Engineering**  
**(Internet of Things and Cyber Security including Blockchain Technology)**  
**Bachelor of Engineering**

**Open Elective -II**

| <b>Course Code</b> | <b>Course Name</b>           |
|--------------------|------------------------------|
| OEC8011            | Enterprise Resource Planning |
| OEC8012            | Cyber Security and Laws      |
| OEC8013            | Energy Audit and Management  |
| OEC8014            | IPR and Patenting            |
| OEC8015            | Environmental Management     |
| OEC8016            | Digital Business Management  |
| OEC8017            | Human Resource Management    |

### Multidisciplinary Minor (MDM)

| Track | Minor Track        | Partner Institute if any | Year/ Sem | Module                                                 | Code     | Eligible                                 |
|-------|--------------------|--------------------------|-----------|--------------------------------------------------------|----------|------------------------------------------|
| 1     | Machine Learning   | SIES GST                 | SE/IV     | Artificial Intelligence                                | MDMC4011 | IT/EXTC/<br>CSE IOT                      |
|       |                    |                          | TE/V      | Machine Learning                                       | MDMC5012 |                                          |
|       |                    |                          |           | Machine Learning Lab                                   | MDML5011 |                                          |
|       |                    |                          | TE/VI     | Natural Language Processing                            | MDMC6013 |                                          |
|       |                    |                          |           | Natural Language Processing Lab                        | MDML6012 |                                          |
|       |                    |                          | BE/VII    | Deep Learning                                          | MDMC7014 |                                          |
|       |                    |                          |           | Deep Learning lab                                      | MDML7013 |                                          |
| 2     | Data Science       | SIES GST                 | SE/IV     | Statistical Foundation for Data Science                | MDMC4021 | ECS/CE/EXTC                              |
|       |                    |                          | TE/V      | Data Analytics & Visualization                         | MDMC5022 |                                          |
|       |                    |                          |           | Data Analytics & Visualization Lab                     | MDML5021 |                                          |
|       |                    |                          | TE/VI     | Decision Making & Business Intelligence                | MDMC6023 |                                          |
|       |                    |                          |           | Decision Making & Business Intelligence Lab            | MDML6022 |                                          |
|       |                    |                          | BE/VII    | Big Data Analytics                                     | MDMC7024 |                                          |
|       |                    |                          |           | Big Data Analytics Lab                                 | MDML7023 |                                          |
| 3     | Embedded Systems   | SIES GST                 | SE/IV     | Microprocessor and Microcontrollers                    | MDMC4031 | CE/AIDS/AIML                             |
|       |                    |                          | TE/V      | RTOs and Embedded systems                              | MDMC5032 |                                          |
|       |                    |                          |           | RTOs and Embedded systems Lab                          | MDML5031 |                                          |
|       |                    |                          | TE/VI     | Sensor Technology                                      | MDMC6033 |                                          |
|       |                    |                          |           | Sensor Technology Lab                                  | MDML6032 |                                          |
|       |                    |                          | BE/VII    | Industrial Internet of Things                          | MDMC7034 |                                          |
|       |                    |                          |           | Industrial Internet of Things Lab                      | MDML7033 |                                          |
| 4     | Cyber Security     | SIES GST                 | SE/IV     | Computer Network                                       | MDMC4041 | AIDS/AIML                                |
|       |                    |                          | TE/V      | Cryptography & System Security                         | MDMC5042 |                                          |
|       |                    |                          |           | Cryptography & System Security Lab                     | MDML5041 |                                          |
|       |                    |                          | TE/VI     | Cloud Computing and Security                           | MDMC6043 |                                          |
|       |                    |                          |           | Cloud Computing and Security Lab                       | MDML6042 |                                          |
|       |                    |                          | BE/VII    | Digital Forensics                                      | MDMC7044 |                                          |
|       |                    |                          |           | Digital Forensics Lab                                  | MDML7043 |                                          |
| 5     | System Programming | SIES GST                 | SE/IV     | Advance Data Structure                                 | MDMC4051 | CSEIOT/ECS/<br>IT                        |
|       |                    |                          | TE/V      | Advance Algorithm                                      | MDMC5052 |                                          |
|       |                    |                          |           | Advance Algorithm Lab                                  | MDML5051 |                                          |
|       |                    |                          | TE/VI     | System Programming and Compiler Construction           | MDMC6053 |                                          |
|       |                    |                          |           | System Programming and Compiler Construction Lab       | MDML6052 |                                          |
|       |                    |                          | BE/VII    | Distributed Systems                                    | MDMC7054 |                                          |
|       |                    |                          |           | Distributed Systems Lab                                | MDML7053 |                                          |
| 6     | Management         | SIES SBS                 | SE/IV     | Cost Management                                        | MDMC4061 | EXTC/CE/IT/<br>ECS/AIDS/<br>AIML/CSE IOT |
|       |                    |                          | TE/V      | Supply Chain Management                                | MDMC5062 |                                          |
|       |                    |                          | TE/VI     | Organizational Behaviour and Human Resource Management | MDMC6063 |                                          |
|       |                    |                          | BE/VII    | Marketing Management                                   | MDMC7064 |                                          |

| Course Code | Course Name                       | Teaching Scheme (Hrs.) |           |          | Credits Assigned |           |          |       |
|-------------|-----------------------------------|------------------------|-----------|----------|------------------|-----------|----------|-------|
|             |                                   | Theory                 | Practical | Tutorial | Theory           | Practical | Tutorial | Total |
| CSEC501     | Cryptography and Network Security | 03                     | -         | -        | 03               | -         | -        | 03    |

| Course Code | Course Name                       | Examination Scheme |     |                  |      |      |       |
|-------------|-----------------------------------|--------------------|-----|------------------|------|------|-------|
|             |                                   | Theory Marks       |     |                  | CIAP | ESEP | Total |
|             |                                   | Course Assessment  |     | ESE <sup>s</sup> |      |      |       |
|             |                                   | ISE                | MSE |                  |      |      |       |
| CSEC501     | Cryptography and Network Security | 20                 | 20  | 60               | --   | --   | 100   |

**Pre-requisite:**

1. CSEC402: Operating System
2. CSEC403: Computer Network

**Program Outcomes addressed:**

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO3: Design/Development of solutions
4. PO6: The Engineer and The World
5. PO7: Ethics
6. PO11: Life-Long Learning

**Course Objectives:**

1. To understand basic security concepts, classical cryptographic techniques, and the need for secure communication.
2. To get knowledge of symmetric key cryptography, mathematical foundations, and modern block cipher algorithms.
3. To get knowledge of asymmetric key cryptography, major public-key algorithms, and key management mechanisms.
4. To understand cryptographic hash functions, digital certificates, and authentication protocols.
5. To get insight into access control mechanisms, formal security models, and Network Access Control (NAC) implementations.
6. To analyze network security threats, DoS attacks, and Internet security protocols with practical relevance.

**Course Outcomes: Learners will be able to**

1. Apply basic security principles and classical cryptographic techniques to secure communication.
2. Explain and apply mathematical foundations and symmetric key cryptographic algorithms.
3. Apply asymmetric key cryptographic techniques and key management mechanisms.
4. Analyze cryptographic hash functions, digital certificates, and authentication protocols.
5. Evaluate access control models and assess NAC enforcement techniques.
6. Analyze network security threats, DoS attack mechanisms, and major Internet security protocols.

| Module No. | Unit No.   | Topics                                                                                                                                                    | Hrs.      | CO         |
|------------|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|------------|
| <b>1.0</b> |            | <b>Introduction to Security Concepts and Basic Cryptography</b>                                                                                           | <b>08</b> |            |
|            | <b>1.1</b> | Basic understanding of computer networks and operating systems concepts, Security Goals, Services, Mechanisms and Types of Security Attacks.              |           | <b>CO1</b> |
|            | <b>1.2</b> | The TCP/IP security architecture, Network security model.                                                                                                 |           |            |
|            | <b>1.3</b> | Concept of Cryptography, Classical Encryption techniques: Classical Encryption techniques: mono-alphabetic and poly-alphabetic.                           |           |            |
|            | <b>1.4</b> | Substitution Techniques: Caesar Cipher, Multiplicative Cipher, Affine Cipher, Autokey Cipher, Vigenère Cipher, Playfair Cipher, Hill Cipher.              |           |            |
|            | <b>1.5</b> | Transposition Techniques: Keyed and Keyless Transposition Ciphers, Introduction to Steganography.                                                         |           |            |
|            |            | <b>Self-Learning:</b> Homomorphic Encryption, Basics of Quantum Cryptography, Security attacks and prevention mechanisms in IoT.                          |           |            |
| <b>2.0</b> |            | <b>Symmetric Key Cryptography</b>                                                                                                                         | <b>07</b> |            |
|            | <b>2.1</b> | Euclidean algorithm, Modular Arithmetic, Prime Numbers, Fermat's and Theorem, Congruence Relation, Chinese Remainder Theorem.                             |           | <b>CO2</b> |
|            | <b>2.2</b> | Block Cipher Principles, Block Cipher Modes of Operation, DES, Double DES, Triple DES, Advanced Encryption Standard (AES), Stream Ciphers: RC5 algorithm. |           |            |

**SIES Graduate School of Technology**  
**Department of Computer Science and Engineering**  
**(Internet of Things and Cyber Security including Blockchain Technology)**  
**Bachelor of Engineering**

|            |            |                                                                                                                                                                                                                                                                                                                                 |           |            |
|------------|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|------------|
|            |            | <b>Self-Learning:</b> Basics of Linear cryptanalysis and Differential Cryptanalysis Classification for medical diagnosis, IoT Protocols that use AES Encryption.                                                                                                                                                                |           |            |
| <b>3.0</b> |            | <b>Asymmetric Key Cryptography and Key Management</b>                                                                                                                                                                                                                                                                           | <b>06</b> |            |
|            | <b>3.1</b> | Public key cryptography, Principles of public key cryptosystems, The RSA algorithm, The knapsack algorithm, and ElGamal Algorithm.                                                                                                                                                                                              |           | <b>CO3</b> |
|            | <b>3.2</b> | Key management Techniques: Using Symmetric and Asymmetric algorithms and Trusted Third Party, Diffie Hellman key exchange algorithm.                                                                                                                                                                                            |           |            |
|            |            | <b>Self-learning:</b> Elliptic Curve Cryptography (ECC), Practical use cases of RSA, ElGamal and Diffie Hellman key exchange algorithm in IOT, AWS IoT CA.                                                                                                                                                                      |           |            |
| <b>4.0</b> |            | <b>Cryptographic Hash Functions, Digital Certificates and Authentication Protocols</b>                                                                                                                                                                                                                                          | <b>08</b> |            |
|            | <b>4.1</b> | Cryptographic Hash Functions, Properties of Secure Hash Function, MAC, HMAC, CMAC, MD5, SHA-256.                                                                                                                                                                                                                                |           | <b>CO4</b> |
|            | <b>4.2</b> | Digital Certificate: X.509, PKI, Digital Signature Schemes: RSA, ElGamal.                                                                                                                                                                                                                                                       |           |            |
|            | <b>4.3</b> | User Authentication and Entity Authentication, Needham Schroeder Authentication Protocol, Kerberos Authentication Protocol.                                                                                                                                                                                                     |           |            |
|            |            | <b>Self-Learning:</b> SHA-512, Use of Hash function, HMAC/CMAC, X.509 in IOT                                                                                                                                                                                                                                                    |           |            |
| <b>5.0</b> |            | <b>Access Control</b>                                                                                                                                                                                                                                                                                                           | <b>04</b> |            |
|            | <b>5.1</b> | Access Control Lists, Access Control Models: Discretionary Access Control (DAC), Mandatory Access Control (MAC), Role-Based Access Control (RBAC), Rule-Based Access Control, Attribute-Based Access Control (ABAC) and Time based access control (TBAC), Security Models: Bell–LaPadula Model, Biba Model, Clark–Wilson Model. |           | <b>CO5</b> |
|            | <b>5.2</b> | NAC: Principle Elements of NAC, Principal NAC Enforcement Methods, How to Implement NAC Solutions.                                                                                                                                                                                                                              |           |            |
|            |            | <b>Self-Learning:</b> Basics of Covert Channels, ACL models used in smart IOT and smart home, Implementation of NAC Solutions for IoT.                                                                                                                                                                                          |           |            |
| <b>6.0</b> |            | <b>Network Security</b>                                                                                                                                                                                                                                                                                                         | <b>06</b> |            |
|            | <b>6.1</b> | Network security basics: TCP/IP vulnerabilities (Layer wise), Packet Sniffing, ARP spoofing,                                                                                                                                                                                                                                    |           |            |

|  |            |                                                                                                                                                             |           |            |
|--|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|------------|
|  |            | port scanning, IP spoofing, TCP SYN flood, DNS Spoofing.                                                                                                    |           |            |
|  | <b>6.2</b> | Denial of Service: Classic DOS attacks, Source Address spoofing, ICMP flood, SYN flood, UDP flood.                                                          |           |            |
|  | <b>6.3</b> | Internet Security Protocols: SSL, IPSEC, Secure Email: PGP, Next-Generation Firewall, IDS and types.                                                        |           |            |
|  |            | <b>Self-learning:</b> Types of malwares, DoS Mitigation Techniques, Common Network Attacks on IoT, IPsec in IoT, Intrusion Detection Systems (IDS) for IoT. |           |            |
|  |            | <b>Total</b>                                                                                                                                                | <b>39</b> | <b>CO6</b> |

#### Text Books:

1. W. Stallings, Cryptography and Network Security: Principles and Practice, 8th ed., Boston, MA, USA: Pearson, 2024.
2. B. A. Forouzan, Cryptography and Network Security, Rev. ed. New Delhi, India: Tata McGraw-Hill, 2011.
3. B. L. Menezes and R. Kumar, Cryptography, Network Security, and Cyber Laws, 1st ed. New Delhi, India: Cengage Learning, 2018.
4. E. Cole, Network Security Bible, 2nd ed. Hoboken, NJ, USA: Wiley, Mar. 2011.
5. W. Stallings and L. Brown, Computer Security: Principles and Practice, 5th ed., Boston, MA, USA: Pearson, 2024.

#### References:

1. B. Schneier, Applied Cryptography: Protocols, Algorithms, and Source Code in C, 20th Anniversary ed. Hoboken, NJ, USA: Wiley, 2015.
2. A. Kahate, Cryptography and Network Security, 4th ed. New Delhi, India: McGraw-Hill Education, 2022.
3. C. Paar, J. Pelzl, and T. Güneysu, Understanding Cryptography: From Established Symmetric and Asymmetric Ciphers to Post-Quantum Algorithms, 2nd ed. Cham, Switzerland: Springer, 2024.
4. M. Liyanage, A. Braeken, P. Kumar, and M. Ylianttila, Eds., IoT Security: Advances in Authentication. Hoboken, NJ, USA: Wiley, 2020.
5. F. Hu, Security and Privacy in Internet of Things (IoTs). Boca Raton, FL, USA: CRC Press, 2020.

#### Online Resources:

1. Cryptography Tutorial (GeeksforGeeks): <https://www.geeksforgeeks.org/cryptography/>
2. NPTEL Course: [https://onlinecourses.nptel.ac.in/noc22\\_cs90/preview](https://onlinecourses.nptel.ac.in/noc22_cs90/preview)
3. Coursera Course: <https://www.coursera.org/learn/crypto>
4. Coursera Course: <https://www.coursera.org/learn/mathematical-foundations-cryptography>
5. Tutorial Point: <https://www.tutorialspoint.com/cryptography>

**Course Assessment:**

**ISE:**

- To be conducted in any of these forms - Assignment/ Quiz/ Presentation/ Class Test/ Case study etc. of 20 marks.
- ISE 20 marks=5 marks attendance + 15 marks for activities.

**MSE:**

- To be conducted as written examination for 20 marks (on 40% - 50% syllabus).

**End Semester examination:**

**\$ ESE of duration 03 hours are of 80 marks and scaled to 60.**

1. Question paper will comprise of 03 questions.
2. Question1 (20 marks): - Solve any 04 out of 06. All questions carry 05 marks each.
3. Question 2 (40 marks): - Solve any 04 out of 06. All questions carry 10 marks each.
4. Question3 (20 marks): - Solve any 04 out of 06. All questions carry 05 marks each.
5. All COs should be mapped as per the weightage in the syllabus

| Course Code | Course Name                                 | Teaching Scheme (Hrs.) |           |          | Credits Assigned |           |          |       |
|-------------|---------------------------------------------|------------------------|-----------|----------|------------------|-----------|----------|-------|
|             |                                             | Theory                 | Practical | Tutorial | Theory           | Practical | Tutorial | Total |
| CSEC502     | Software Engineering and Project Management | 03                     | --        | --       | 03               | --        | --       | 03    |

| Course Code | Course Name                                 | Examination Scheme |     |                   |      |      |       |
|-------------|---------------------------------------------|--------------------|-----|-------------------|------|------|-------|
|             |                                             | Theory Marks       |     |                   | CIAP | ESEP | Total |
|             |                                             | Course Assessment  |     | ESE <sup>\$</sup> |      |      |       |
|             |                                             | ISE                | MSE |                   |      |      |       |
| CSEC502     | Software Engineering and Project Management | 20                 | 20  | 60                | --   | --   | 100   |

**Pre- requisite:**

1. FEL205: Object Oriented Programming Methodology Lab
2. CSEL403: Skill Lab - Web Technology

**Program Outcomes Addressed:**

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO3: Design/Development of Solutions
4. PO8: Individual and Collaborative Team work.
5. PO9: Communication
6. PO11: Life-Long Learning

**Course Objectives:**

1. To understand software engineering concepts, processes, and development models.
2. To explain requirements of engineering activities and requirement modeling techniques.
3. To analyze software design principles and develop structured design solutions.
4. To analyze project estimation, scheduling, and metrics for effective project management.
5. To evaluate software risks, configuration management, and change control processes.
6. To evaluate and construct testing approaches and test strategies for software quality assurance.

**Course Outcomes: Learners will be able to**

1. Understand fundamental concepts of software engineering and process models.
2. Analyze user requirements and develop appropriate requirement models.
3. Apply design principles to design architectural, component, and UI models.
4. Evaluate project metrics and develop project schedules using PM tools.
5. Identify and manage software risks and configuration changes in projects.
6. Apply software testing strategies and implement unit, integration, and system tests.

| Module No. | Unit No. | Topics                                                                                                                                                                                                                                                                                                      | Hrs. | CO  |
|------------|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-----|
| 1.0        |          | <b>Introduction to Software Engineering and Process Models</b>                                                                                                                                                                                                                                              | 08   |     |
|            | 1.1      | Object Oriented Programming Methodology, Web Technology.<br><b>Introduction to Software Engineering and Process Models:</b><br>Nature of Software, Software Engineering, Software Process, CMM, Generic Process Model.                                                                                      |      |     |
|            | 1.2      | <b>Prescriptive Process Models:</b> The Waterfall Model, V Model.                                                                                                                                                                                                                                           |      |     |
|            | 1.3      | <b>Incremental Process Model:</b> Incremental Model                                                                                                                                                                                                                                                         |      |     |
|            | 1.4      | <b>Evolutionary Process Models:</b> Prototyping Paradigm, The Spiral Model                                                                                                                                                                                                                                  |      |     |
|            | 1.5      | <b>Concurrent Process Models:</b> Concurrent Process Model                                                                                                                                                                                                                                                  |      |     |
|            | 1.6      | <b>Agile Methodology:</b> Agility Principals, Agile Process Models: Extreme Programming (XP), Adaptive Software Development (ASD), Dynamic Systems Development Method (DSDM), Scrum, Crystal, Feature Driven Development (FDD), Agile Modelling (AM), Kanban Model.                                         |      |     |
|            |          | <b>Self-Learning Topics: Case Study Topics:</b><br>1. <b>E-commerce Website using Waterfall:</b> A company used the waterfall model to build a simple shopping website with fixed requirements.<br>2. <b>Mobile App using Agile:</b> A startup released new app features every 2 weeks using Scrum sprints. |      |     |
| 2.0        |          | <b>Requirements Analysis and Requirements Models</b>                                                                                                                                                                                                                                                        | 07   |     |
|            | 2.1      | <b>Requirement Analysis:</b> Requirement Elicitation, Software Requirement Specification (SRS).                                                                                                                                                                                                             |      |     |
|            | 2.2      | <b>Requirement Models:</b> Scenario Based Models, Class Based Models, Behavioural Models and Flow Models.                                                                                                                                                                                                   |      |     |
|            |          | <b>Self-Learning Topics: Case Study Topics:</b><br>1. <b>Online Exam System:</b> Missing requirements for timer control caused major rework, showing the importance of clear SRS.<br>2. <b>Food Delivery App:</b> User stories helped identify essential features like tracking orders and payment          |      | CO2 |
| 3.0        |          | <b>Design Engineering and Analysis</b>                                                                                                                                                                                                                                                                      | 06   |     |
|            | 3.1      | <b>Design Engineering and Analysis:</b><br>Design Principles, Design Concepts, Effective Modular Design-Cohesion and Coupling.                                                                                                                                                                              |      |     |
|            | 3.2      | <b>Translating the requirement models into the design model. Designs</b><br>Architectural Design, Component Level Design, User Interface Design.                                                                                                                                                            |      | CO3 |
|            |          | <b>Self-Learning Topics: Case Study Topics:</b>                                                                                                                                                                                                                                                             |      |     |

|            |            |                                                                                                                                                                                                                                                                                                                                         |           |            |
|------------|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|------------|
|            |            | <ol style="list-style-type: none"> <li><b>Library System:</b> Using UML diagrams helped visualize book issue and return processes.</li> <li><b>Ride-Sharing App:</b> Simple design patterns improved matching drivers with customers.</li> </ol>                                                                                        |           |            |
| <b>4.0</b> |            | <b>Software Project Management</b>                                                                                                                                                                                                                                                                                                      | <b>08</b> |            |
|            | <b>4.1</b> | <b>Project Management Concepts:</b><br>Management Spectrum, 3Ps                                                                                                                                                                                                                                                                         |           | <b>CO4</b> |
|            | <b>4.2</b> | <b>Process and Project Metrics:</b><br>Metrics in the Process and Project Domains, software measurement, metrics for software quality.                                                                                                                                                                                                  |           |            |
|            | <b>4.3</b> | <b>Software Project Estimation:</b> LOC, FP, Empirical Estimation Models COCOMO I COCOMO II, Specialized Estimation Techniques.                                                                                                                                                                                                         |           |            |
|            | <b>4.4</b> | <b>Software Project Scheduling:</b><br>Work Breakdown Structure, Network Diagram, Gantt Chart, PERT, CPM, Stakeholders and Communication plan, Introduction to Project Management Information System (PMIS).                                                                                                                            |           |            |
|            |            | <b>Self-Learning Topics: Case Study Topics:</b> <ol style="list-style-type: none"> <li><b>School ERP Project:</b> A Gantt chart helped the team complete modules like attendance and fees on time.</li> <li><b>Website Redesign:</b> Poor communication delayed the project, highlighting the need for a communication plan.</li> </ol> |           |            |
| <b>5.0</b> |            | <b>Software Risk Management</b>                                                                                                                                                                                                                                                                                                         | <b>05</b> |            |
|            | <b>5.1</b> | <b>Software Risk Management:</b> Risk Identification, Risk Assessment, Risk Projection, Risk Refinement, RMMM Plan.                                                                                                                                                                                                                     |           | <b>CO5</b> |
|            | <b>5.2</b> | <b>Software Configuration Management:</b><br>SCM, SCM Repositories, SCM Process, Change Control and Version Control.                                                                                                                                                                                                                    |           |            |
|            |            | <b>Self-Learning Topics: Case Study Topics:</b> <ol style="list-style-type: none"> <li><b>ATM Software:</b> Early risk identification (like power failure) prevented downtime.</li> <li><b>Team Coding Work:</b> Using Git avoided issues of overwriting each other's code.</li> </ol>                                                  |           |            |
| <b>6.0</b> |            | <b>Software Testing Fundamentals</b>                                                                                                                                                                                                                                                                                                    | <b>05</b> |            |
|            | <b>6.1</b> | <b>Software Testing Fundamentals:</b> Strategic Approach to Software Testing, Unit Testing, Integration Testing, Verification, Validation Testing, System Testing, Test Strategies for WebApp.                                                                                                                                          |           | <b>CO6</b> |
|            | <b>6.2</b> | <b>Software Testing Techniques:</b> White Box Testing, Basis Path Testing, Control Structure Testing and Black Box Testing. TDD (Test-Driven Development)                                                                                                                                                                               |           |            |
|            |            | <b>Self-Learning Topics: Case Study Topics:</b> <ol style="list-style-type: none"> <li><b>Payment App Bug:</b> A calculation error was caught during unit testing before release.</li> </ol>                                                                                                                                            |           |            |

|  |  |                                                                                                                              |           |  |
|--|--|------------------------------------------------------------------------------------------------------------------------------|-----------|--|
|  |  | 2. <b>Flight Booking System:</b> Black-box testing helped verify booking, cancellation, and payment without seeing the code. |           |  |
|  |  | <b>Total</b>                                                                                                                 | <b>39</b> |  |

**Textbooks:**

1. Roger S. Pressman, *Software Engineering: A Practitioner's Approach*, 9th Edition, McGraw-Hill Education, 2023.
2. Ian Sommerville, *Software Engineering*, 10th Edition, Pearson Education, 2026.
3. Ugrasen Suman, *Software Engineering: Concepts and Practices*, Cengage Learning, 2<sup>nd</sup> Edition 2022.

**Reference books:**

1. Ali Behforooz & Frederick J. Hudson, *Software Engineering Fundamentals*, Oxford University Press, 2<sup>nd</sup> edition, 2007.
2. Pankaj Jalote, *An Integrated Approach to Software Engineering*, Narosa Publishing House, 3<sup>rd</sup> edition, 2005.
3. Jibitesh Mishra & Ashok Mohanty, *Software Engineering*, Pearson Education, 2011.
4. Rajib Mall, *Fundamentals of Software Engineering*, Prentice Hall of India, 5<sup>th</sup> edition, 2018.

**Online References:**

1. NPTEL Course: [https://onlinecourses.swayam2.ac.in/cec21\\_cs21/preview](https://onlinecourses.swayam2.ac.in/cec21_cs21/preview)
2. NPTEL Course: <https://nptel.ac.in/courses/106101061>

**Course Assessment:**

**ISE:**

- To be conducted in any of these forms - Assignment/ Quiz/ Presentation/ Class Test/ Case study etc. of 20 marks.
- ISE 20 marks = 05 marks for attendance + 15 marks for activities.

**MSE:**

- To be conducted as written examination for 20 marks (on 40% - 50% syllabus).

**End Semester Examination:**

**\$ ESE of duration 03 hours are of 80 marks and scaled to 60.**

1. Question paper will comprise of 03 questions.
2. Question1(20 marks): - Solve any 04 out of 06. All questions carry 05 marks each.
3. Question 2 (40 marks): - Solve any 04 out of 06. All questions carry 10 marks each.
4. Question3(20 marks): - Solve any 04 out of 06. All questions carry 05 marks each.
5. All COs should be mapped as per the weightage in the syllabus.

| Course Code | Course Name                           | Teaching Scheme (Hrs.) |           |          | Credits Assigned |           |          |       |
|-------------|---------------------------------------|------------------------|-----------|----------|------------------|-----------|----------|-------|
|             |                                       | Theory                 | Practical | Tutorial | Theory           | Practical | Tutorial | Total |
| CSEC503     | Introduction to Blockchain Technology | 03                     | -         | -        | 03               | -         | -        | 03    |

| Course Code | Course Name                           | Examination Scheme |     |       |      |      |       |
|-------------|---------------------------------------|--------------------|-----|-------|------|------|-------|
|             |                                       | Theory Marks       |     |       | CIAP | ESEP | Total |
|             |                                       | Course Assessment  |     | ESE\$ |      |      |       |
|             |                                       | ISE                | MSE |       |      |      |       |
| CSEC503     | Introduction to Blockchain Technology | 20                 | 20  | 60    | --   | --   | 100   |

**Pre-requisite:**

1. CSEC303 - Discrete Structure and Automata Theory

**Program Outcomes Addressed:**

1. PO1: Engineering Knowledge
2. PO2: Problem Analysis
3. PO6: The Engineer and the World
4. PO7: Ethics
5. PO11: Life-Long Learning

**Course Objectives:**

1. To get acquainted with the concept of Distributed ledger system and Blockchain.
2. To learn the concepts of consensus mechanism in Blockchain.
3. To introduce students to cryptocurrencies, token standards, digital wallets, and the technical functioning of Bitcoin.
4. To provide students with a clear understanding of Ethereum architecture, its components, and the fundamentals of smart contract development.
5. To understand permissioned Blockchain and explore Hyperledger Fabric.
6. To analyze applications and case studies of Blockchain.

**Course Outcomes: Learners will be able to**

1. Explain the basic concept of Blockchain and Distributed Ledger Technology.
2. Analyze and compare major blockchain consensus mechanisms.
3. Explain cryptocurrency concepts and fundamentals of Bitcoin.
4. Explain Ethereum architecture and smart contract lifecycle.
5. Explain Hyperledger Fabric architecture, components, and transaction flow.
6. Analyze blockchain applications through relevant case studies.

| Module No. | Unit No. | Topics                                                                                                                                                                                                                             | Hrs. | CO  |
|------------|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-----|
| 1.0        |          | <b>Introduction to Blockchain Technology</b>                                                                                                                                                                                       | 05   |     |
|            | 1.1      | <b>Introduction:</b> Distributed Ledger Technology, Public and Private DLT, Features of DLT, what is Blockchain? History, Types of Blockchain, Benefits and Limitations of Blockchain                                              |      | CO1 |
|            | 1.2      | <b>Blockchain:</b> Generic Structure of Blockchain, Generic Elements of Blockchain, Block in a Blockchain: Structure of a block, Block header Hash, Block height, The Genesis Block, Linking Blocks in the Blockchain, Merkle Tree |      |     |
|            |          | <b>Self-Learning:</b> CAP Theorem and Blockchain, Blockchain Demo.                                                                                                                                                                 |      |     |
| 2.0        |          | <b>Consensus Mechanisms</b>                                                                                                                                                                                                        | 06   |     |
|            | 2.1      | <b>Introduction:</b> Definition, Need for Consensus Mechanism Byzantine General problem, Double Spending, Types of Consensus Mechanisms                                                                                            |      | CO2 |
|            | 2.2      | <b>Consensus Mechanisms:</b> PoW, PoS, DPoS, PoET, Proof of Activity (PoA), PoST, pBFT, Delegated BFT (dBFT), RAFT, PAXOS, Proof of Authority.                                                                                     |      |     |
|            |          | <b>Self-Learning:</b> Concepts like PoH, VDF, Hybrid consensus mechanisms                                                                                                                                                          |      |     |
| 3.0        |          | <b>Bitcoin and Cryptocurrencies</b>                                                                                                                                                                                                | 07   |     |
|            | 3.1      | Cryptocurrencies: Definition, Advantages of cryptocurrencies over Traditional fiat Currencies, Tokens, Types of Tokens, Token Standards - ERC20 and ERC 721, NFT, Wallets, Types of Wallets, ICO, STO, Altcoin                     |      | CO3 |
|            | 3.2      | <b>Bitcoin:</b> Block Structure, Working of Bitcoin, Bitcoin Addresses, Bitcoin Transactions, Bitcoin Mining, Mining Difficulty, Spending the transaction, Bitcoin Networks, Bitcoin Wallets.                                      |      |     |
|            |          | <b>Self-Learning:</b> Different Cryptocurrencies, DeFi, Metaverse                                                                                                                                                                  |      |     |
| 4.0        |          | <b>Permissionless Blockchain: Ethereum</b>                                                                                                                                                                                         | 08   |     |
|            | 4.1      | Introduction: Components, Ethereum Block, EVM, Ether, Gas, Ethereum Transactions, Accounts, Patricia Merkle, Swarm, Whisper and IPFS, Ethash, Ethereum Network                                                                     |      | CO4 |
|            | 4.2      | <b>Smart Contracts:</b> What is a smart contract, Lifecycle of a smart contract, Introduction to Ethereum High Level Languages, Oracles                                                                                            |      |     |
|            |          | <b>Self-Learning:</b> Smart contract development using Java or Python                                                                                                                                                              |      |     |
| 5.0        |          | <b>Permissioned Blockchain: Hyperledger Fabric</b>                                                                                                                                                                                 | 07   |     |
|            | 5.1      | Introduction to Framework, Tools and Architecture of Hyperledger Fabric Blockchain.                                                                                                                                                |      | CO5 |
|            | 5.2      | <b>Components:</b> Policies, Certificate Authority, Nodes, Clients, Endorsers, Orderers, Committers, Chain code, Ledger, Channels, Hyperledger Fabric Transaction Lifecycle                                                        |      |     |

|            |            |                                                                                                                                                                                         |           |            |
|------------|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|------------|
|            |            | <b>Self-Learning:</b> Fundamentals of Hyperledger Composer, Hyperledger sawtooth, Hyperledger Caliper.                                                                                  |           |            |
| <b>6.0</b> |            | <b>Blockchain Application and Case studies</b>                                                                                                                                          | <b>06</b> |            |
|            | <b>6.1</b> | Blockchain Applications: Domain-Specific Applications: FinTech, IoT, Industrial and Manufacturing, Energy, Supply chain & Logistics, Records and Identities, Healthcare, Cybersecurity. |           | <b>CO6</b> |
|            | <b>6.2</b> | Case Studies: Walmart Food Traceability, The DAO Attack, Mt. Gox Collapse.                                                                                                              |           |            |
|            |            | <b>Self-Learning:</b> Read Technical papers on Blockchain                                                                                                                               |           |            |
|            |            | <b>Total</b>                                                                                                                                                                            | <b>39</b> |            |

#### Textbooks:

1. Antonopoulos and D. A. Harding, *Mastering Bitcoin: Programming the Open Blockchain*, Third Edition
2. Imran Bashir, *Mastering Blockchain: A Deep Dive into Distributed Ledgers, Consensus Protocols, Smart Contracts, DApps, Cryptocurrencies, Ethereum, and More*.
3. M. Zand, X. (B.) Wu, and M. A. Morris, *Hands-On Smart Contract Development with Hyperledger Fabric V2*.
4. A. M. Antonopoulos, *Mastering Bitcoin: Unlocking Digital Cryptocurrencies*. O'Reilly Media
5. A. M. Antonopoulos and G. Wood, *Mastering Ethereum: Building Smart Contracts and DApps*. Sebastopol, CA, USA: O'Reilly Media, 2018.

#### Reference books:

1. A. Lewis, *The Basics of Bitcoins and Blockchains: An Introduction to Cryptocurrencies and the Technology that Powers Them* Coral Gables, FL, USA: Mango Publishing, 2021.
2. N. Gaur et al., *Blockchain with Hyperledger Fabric: Build Decentralized Applications Using Hyperledger Fabric 2*. Packt Publishing Ltd, 2020.
3. K. Saurabh and A. Saxena, *Blockchain Technology: Concepts and Applications*. Wiley.
4. C. Burniske and J. Tatar, *Cryptoassets: The Innovative Investor's Guide to Bitcoin and Beyond*.
5. A. Bansal and V. Madiseti, *Blockchain Applications: A Hands-On Approach*. New York, NY, USA: Columbia University Press, 2019

#### Online References:

1. NPTEL COURSE: [https://onlinecourses.nptel.ac.in/noc22\\_cs44/preview](https://onlinecourses.nptel.ac.in/noc22_cs44/preview)
2. Ethereum Official Documentation & Developer Resources :<https://ethereum.org/en/>
3. Truffle Suite Tutorials for Ethereum Development :<https://www.trufflesuite.com/tutorials>
4. Hyperledger Fabric Documentation :<https://hyperledger-fabric.readthedocs.io/en/release-2.2/>
5. Blockchain Demo :<https://andersbrownworth.com/blockchain/blockchain>
6. Public/Private Key Cryptography Demo :<https://andersbrownworth.com/blockchain/public-private-keys/>

**ISE:**

- To be conducted in any of these forms - Assignment/ Quiz/ Presentation/ Class Test/ Case study etc. of 20 marks
- ISE 20 marks=05 marks for attendance + 15 marks for activities

**MSE:**

- To be conducted as written examination for 20 marks (on 40% -50% syllabus).

**End Semester Examination:**

**\$ ESE of duration 03 hours are of 80 marks and scaled to 60.**

1. Question paper will comprise of 03 questions.
2. Question1(20 marks): - Solve any 04 out of 06. All questions carry 05 marks each.
3. Question 2 (40 marks): - Solve any 04 out of 06. All questions carry 10 marks each.
4. Question 3 (20 marks): - Solve any 04 out of 06. All questions carry 05 marks each.
5. All COs should be mapped as per the weightage in the syllabus.

| Course Code | Course Name      | Teaching Scheme (Hrs.) |           |          | Credits Assigned |           |          |       |
|-------------|------------------|------------------------|-----------|----------|------------------|-----------|----------|-------|
|             |                  | Theory                 | Practical | Tutorial | Theory           | Practical | Tutorial | Total |
| MDMC 5012   | Machine Learning | 3                      | --        | --       | 3                | --        | --       | 3     |

| Course Code | Course Name      | Examination Scheme |     |       |      |      |       |
|-------------|------------------|--------------------|-----|-------|------|------|-------|
|             |                  | Theory Marks       |     |       | CIAP | ESEP | Total |
|             |                  | Course Assessment  |     | ESE\$ |      |      |       |
|             |                  | ISE                | MSE |       |      |      |       |
| MDMC5012    | Machine Learning | 20                 | 20  | 60    | --   | --   | 100   |

**Pre- requisite:**

1. MDMC4011: Artificial Intelligence

**Program Outcomes Addressed**

1. PO1: Engineering Knowledge
2. PO2: Problem Analysis
3. PO3: Design/Development of solutions
4. PO4: Conduct investigation of complex problem
5. PO7: Ethics

**Course Objectives:**

1. To introduce Machine learning concepts.
2. To explain various supervised Machine Learning Techniques.
3. To describe various unsupervised Machine Learning Techniques
4. To highlight the importance of Dimensionality Reduction and apply it in ML.
5. To introduce the foundational concepts, architectures, and learning mechanisms of Artificial Neural Networks and developing basic neural network-based learning models
6. To provide students with a comprehensive understanding of ensemble learning techniques.

**Course Outcomes: Learners will be able to**

1. Explain the basics of Machine Learning
2. Apply various supervised Machine Learning Techniques.
3. Apply various unsupervised Machine Learning Techniques.
4. Apply Dimensionality Reduction techniques.
5. Evaluate ensemble learning techniques to real world problems.
6. Analyze the perceptron model, including its learning rules, capabilities, and limitations for linearly separable problems.

| Module No. | Unit No.   | Topics                                                                                                                                                                                                                                                           | Hrs.      | CO         |
|------------|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|------------|
| <b>1.0</b> |            | <b>Machine Learning Basics</b>                                                                                                                                                                                                                                   | <b>06</b> |            |
|            | <b>1.1</b> | Introduction to Machine learning, Key Terminologies, Types of ML: Supervised learning, Unsupervised learning, Reinforcement learning Applications of ML, Steps in developing ML applications, Issues in Machine Learning, overfitting and underfitting of model. |           | <b>CO1</b> |
|            | <b>1.2</b> | Introduction to Data Preprocessing, Data Collection, Data Cleaning, Data splitting for training, validation & Test                                                                                                                                               |           |            |
|            |            | <b>Self-learning Topics:</b> Advanced Data Preprocessing Techniques                                                                                                                                                                                              |           |            |
| <b>2.0</b> |            | <b>Supervise Learning</b>                                                                                                                                                                                                                                        | <b>08</b> |            |
|            | <b>2.1</b> | Linear Regression, Multiple Linear Regression, Logistic Regression.                                                                                                                                                                                              |           | <b>CO2</b> |
|            | <b>2.2</b> | Decision Tree classification: ID3, KNN, SVM., Basics of Kernel trick.                                                                                                                                                                                            |           |            |
|            | <b>2.3</b> | Performance measures classification: Confusion Matrix, Accuracy, Precision, Recall<br>Performance measures regression: MSE, RMSE, MAE                                                                                                                            |           |            |
|            |            | <b>Self-learning Topics:</b> CART                                                                                                                                                                                                                                |           |            |
| <b>3.0</b> |            | <b>Unsupervised Learning</b>                                                                                                                                                                                                                                     | <b>07</b> |            |
|            | <b>3.1</b> | Introduction, Supervised vs Unsupervised Learning, Advantages and disadvantages of Unsupervised learning, Application, Challenges                                                                                                                                |           | <b>CO3</b> |
|            | <b>3.2</b> | Clustering: types. Algorithms: K-means, K-medoid, Agglomerative (Single linkage, complete linkage, average linkage, centroid based), Divisive, DBSCAN.                                                                                                           |           |            |
|            |            | <b>Self-learning Topics:</b> Association rule Learning: Apriori Algorithm. Real world use cases of unsupervised learning: Healthcare, finance                                                                                                                    |           |            |
| <b>4.0</b> |            | <b>Dimensionality Reduction</b>                                                                                                                                                                                                                                  | <b>04</b> |            |
|            | <b>4.1</b> | Introduction to Dimensionality Reduction, Curse of Dimensionality.                                                                                                                                                                                               |           | <b>CO4</b> |
|            | <b>4.2</b> | Feature Selection (FS): Filter, Wrapper, Embedded approaches.                                                                                                                                                                                                    |           |            |
|            | <b>4.3</b> | Feature Extraction (FE): Principal Component Analysis (PCA). FS vs FE.                                                                                                                                                                                           |           |            |
|            |            | <b>Self-learning Topics:</b> Autoencoders for Dimensionality Reduction/ PCA vs Autoencoders.                                                                                                                                                                     |           |            |
| <b>5.0</b> |            | <b>Ensemble Learning</b>                                                                                                                                                                                                                                         | <b>08</b> |            |
|            | <b>5.1</b> | Introduction, Why Ensemble Methods? Basic Ensemble                                                                                                                                                                                                               |           | <b>CO5</b> |

|     |     |                                                                                                                                                                                                                                                                                                                                                               |           |     |
|-----|-----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|-----|
|     |     | Techniques: Averaging methods, Voting methods                                                                                                                                                                                                                                                                                                                 |           |     |
|     | 5.2 | Types of Ensemble Techniques: Bagging, Boosting, Stacking, Blending.                                                                                                                                                                                                                                                                                          |           |     |
|     | 5.3 | Bagging Methods: Random Forest. Boosting Methods: AdaBoost, XGBoost.                                                                                                                                                                                                                                                                                          |           |     |
|     |     | <b>Self-learning Topics:</b> Out-of-Bag (OOB) Error Estimation                                                                                                                                                                                                                                                                                                |           |     |
| 6.0 |     | <b>Introduction to Artificial Neural Networks</b>                                                                                                                                                                                                                                                                                                             | 06        |     |
|     | 6.1 | Introduction to Artificial Neural Networks, basic concepts, evolution of neural networks, biological neuron vs artificial neuron, McCulloch–Pitts model, ANN architecture, bias, weights and activation functions (binary, bipolar, sigmoid, Tanh, ReLU), perceptron model, linearly separable and non-separable patterns, and limitations of the perceptron. |           | CO6 |
|     | 6.2 | Perceptron Learning Rule, Delta Learning Rule (LMS / Widrow–Hoff), introduction to multilayer perceptron (MLP), forward propagation, Gradient Descent, the backpropagation algorithm.                                                                                                                                                                         |           |     |
|     |     | <b>Self-learning Topics:</b> Basic applications of ANN in classification and regression tasks.                                                                                                                                                                                                                                                                |           |     |
|     |     | <b>Total</b>                                                                                                                                                                                                                                                                                                                                                  | <b>39</b> |     |

#### Textbooks:

1. P. Harrington, Machine Learning in Action, 1st ed. New Delhi, India: DreamTech Press, 2012.
2. N. Japkowicz and M. Shah, Evaluating Learning Algorithms, 1st ed. Cambridge, U.K.: Cambridge University Press, 2011.
3. E. Alpaydm, Introduction to Machine Learning, 4th ed. Cambridge, MA, USA: MIT Press, 2020.
4. P. Flach, Machine Learning, 2nd ed. Cambridge, U.K.: Cambridge University Press, 2022.
5. T. M. Mitchell, Machine Learning, 2nd ed. New York, NY, USA: McGraw-Hill, 1997.
6. Z.-H. Zhou, Ensemble Methods: Foundations and Algorithms, 1st ed. Boca Raton, FL, USA: CRC Press, 2012.

#### Reference books:

1. J. Han, M. Kamber, and J. Pei, Data Mining: Concepts and Techniques, 4th ed. San Francisco, CA, USA: Morgan Kaufmann, 2022.
2. M. H. Dunham, Data Mining: Introductory and Advanced Topics, 1st ed. Upper Saddle River, NJ, USA: Pearson, 2006.
3. K. P. Murphy, Machine Learning: A Probabilistic Perspective, 1st ed. Cambridge, MA, USA: MIT Press, 2012.
4. S. Roy and U. Chakraborty, Introduction to Soft Computing. Noida, India: Pearson, 2024.
5. R. O. Duda, P. E. Hart, and D. G. Stork, Pattern Classification, 2nd ed. New York, NY, USA: Wiley, 2000.



**Online References:**

1. Data sets for Machine Learning algorithms - <https://www.kaggle.com/datasets>
2. Machine Learning repository - <https://archive.ics.uci.edu/ml/index.php>
3. Machine Learning from Coursera - <https://www.coursera.org/collections/machine->
4. <https://towardsdatascience.com/machine-learning/home>
5. NPTEL course -Introduction to Machine Learning – IITKGP, Prof. Sudeshna Sark  
[https://onlinecourses.nptel.ac.in/noc21\\_cs85/preview](https://onlinecourses.nptel.ac.in/noc21_cs85/preview)

**Course Assessment:**

**ISE:**

- To be conducted in any of these forms - Assignment/ Quiz/ Presentation/ Class Test/ Case study etc. of 20 marks.
- ISE 20 marks = 05 marks for attendance + 15 marks for activities.

**MSE:**

- To be conducted as written examination for 20 marks (on 40% - 50% syllabus)

**End Semester Examination:**

**\$ ESE of duration 03 hours are of 80 marks and scaled to 60.**

1. Question paper will comprise of 03 questions.
2. Question1(20 marks): - Solve any 04 out of 06. All questions carry 05 marks each.
3. Question 2 (40 marks): - Solve any 04 out of 06. All questions carry 10 marks each.
4. Question 3(20 marks): - Solve any 04 out of 06. All questions carry 05 marks each.
5. All COs should be mapped as per the weightage in the syllabus.

| Course Code | Course Name       | Teaching Scheme (Hrs.) |           |          | Credits Assigned |           |          |       |
|-------------|-------------------|------------------------|-----------|----------|------------------|-----------|----------|-------|
|             |                   | Theory                 | Practical | Tutorial | Theory           | Practical | Tutorial | Total |
| MDMC5052    | Advance Algorithm | 3                      | -         | -        | 3                | -         | -        | 3     |

| Course Code | Course Name       | Examination Scheme |     |                   |      |      |       |
|-------------|-------------------|--------------------|-----|-------------------|------|------|-------|
|             |                   | Theory Marks       |     |                   | CIAP | ESEP | Total |
|             |                   | Course Assessment  |     | ESE <sup>\$</sup> |      |      |       |
|             |                   | ISE                | MSE |                   |      |      |       |
| MDMC5052    | Advance Algorithm | 20                 | 20  | 60                | -    | -    | 100   |

**Pre- requisite:**

1. FEC104: C Programming
2. CSEC302: Data Structures & Algorithms

**Program Outcomes Addressed:**

1. PO1: Engineering Knowledge
2. PO2: Problem Analysis
3. PO3: Design/Development of Solutions
4. PO4: Conduct Investigations of Complex Problems
5. PO11: Life-Long Learning

**Course Objectives:**

1. To learn mathematical background for analysis of algorithm.
2. To enable students to apply probabilistic and randomized techniques to evaluate the performance of algorithms in uncertain environments.
3. To learn and design dynamic programming solutions for optimization problems and analyze their correctness and efficiency.
4. To understand and apply graph flow techniques for network problems.
5. To apply linear programming and computational geometry methods to analyze geometric and optimization problems.
6. To learn advanced algorithms.

**Course Outcomes: Learners will be able to**

1. Understand analysis techniques for algorithms.
2. Appreciate the role of probability and randomization in the analysis of algorithms.
3. Apply dynamic programming techniques to solve a given problem.
4. Appreciate the role of graph algorithms in solving a variety of problems.
5. Apply linear programming and geometric algorithms to model and solve real-world computational problems.
6. Understand the concepts of Optimization, Approximation and multithreaded algorithms.

| Module No. | Unit No.   | Topics                                                                                                                                                                                                                       | Hrs.      | Mapped to Course Outcome |
|------------|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|--------------------------|
| <b>1.0</b> |            | <b>Introduction</b>                                                                                                                                                                                                          | <b>07</b> |                          |
|            | <b>1.1</b> | Fundamentals of the analysis of algorithms: Time and Space complexity, Asymptotic analysis and notation, average and worst-case analysis.                                                                                    |           | <b>CO1</b>               |
|            | <b>1.2</b> | Recurrences: The substitution method, Recursive tree method, Masters method, proving technique (contradiction, mathematical induction).                                                                                      |           |                          |
|            |            | <b>Self-learning Topics:</b> Amortized analysis- aggregate analysis, accounting analysis, potential analysis dynamic tables.                                                                                                 |           |                          |
| <b>2.0</b> |            | <b>Probabilistic Analysis and Randomized Algorithm</b>                                                                                                                                                                       | <b>08</b> |                          |
|            | <b>2.1</b> | Probabilistic and Randomized Algorithm: Probabilistic approach to algorithm and Randomized Analysis, Indicator Random Variable (IRV), Randomized Quick Sort, Analysis of Hiring Problem, Las Vegas and Monte Carlo algorithm |           | <b>CO2</b>               |
|            |            | <b>Self-learning Topics:</b> Balls-in-bins problem, randomized algorithms for 2-SAT                                                                                                                                          |           |                          |
| <b>3.0</b> |            | <b>Dynamic algorithms</b>                                                                                                                                                                                                    | <b>07</b> |                          |
|            | <b>3.1</b> | Introduction to Dynamic Algorithms, all pair shortest path, 0/1 knapsack, travelling salesman problem, Matrix Chain Multiplication, Optimal binary search tree, Analysis of All algorithms and problem solving.              |           | <b>CO3</b>               |
|            |            | <b>Self-learning Topics:</b> OBST, Johnson' algorithm for Flow shop scheduling                                                                                                                                               |           |                          |
| <b>4.0</b> |            | <b>Maximum Flow networks</b>                                                                                                                                                                                                 | <b>06</b> |                          |
|            | <b>4.1</b> | Augmenting path algorithms: Flow networks, The Ford-Fulkerson method, Edmond-Karp, Max-Flow Min-Cut Theorem, Push Relabel algorithm.                                                                                         |           | <b>CO4</b>               |
|            | <b>4.2</b> | Bipartite Matching: Maximum bipartite matching                                                                                                                                                                               |           |                          |
|            |            | <b>Self-learning Topics:</b> The relabel-to-front algorithm                                                                                                                                                                  |           |                          |
| <b>5.0</b> |            | <b>Linear Programming and Computational Geometry</b>                                                                                                                                                                         | <b>07</b> |                          |
|            | <b>5.1</b> | Linear Programming: Introduction to linear programming, geometric interpretation, LP duality, Simplex algorithm.                                                                                                             |           | <b>CO5</b>               |
|            | <b>5.2</b> | Computational Geometry: Line Segment Properties, Convex Hull Graham's scan algorithm, Conic Programming                                                                                                                      |           |                          |
|            | <b>5.3</b> | Geometric Searching: Point Location in polygon using Ray Crossing                                                                                                                                                            |           |                          |
|            |            | <b>Self-learning Topics:</b> Competitive Ratio, K-Server                                                                                                                                                                     |           |                          |
| <b>6.0</b> |            | <b>Advanced Algorithms and NP problems</b>                                                                                                                                                                                   | <b>04</b> |                          |

|  |            |                                                                                           |           |            |
|--|------------|-------------------------------------------------------------------------------------------|-----------|------------|
|  | <b>6.1</b> | Optimization Algorithms: Genetic algorithm (GA)                                           |           | <b>CO6</b> |
|  | <b>6.2</b> | Approximation Algorithms: Vertex-cover problem                                            |           |            |
|  | <b>6.3</b> | Multithreaded algorithms: Merge sort.                                                     |           |            |
|  | <b>6.4</b> | Introduction to NP-Hard and NP-Complete Problems                                          |           |            |
|  |            | <b>Self-learning Topics:</b> Implementation of Genetic algorithm and Vertex-cover problem |           |            |
|  |            | <b>Total</b>                                                                              | <b>39</b> |            |

### Textbooks:

1. T. H. Cormen, C. E. Leiserson, R. L. Rivest, and C. Stein, *Introduction to Algorithms*, 4th ed. Cambridge, MA, USA: MIT Press, 2022.
2. H. Bhasin, *Algorithms: Design and Analysis*. New Delhi, India: Oxford University Press, 2016.
3. E. Horowitz, S. Sahni, and S. Rajasekaran, *Fundamentals of Computer Algorithms*. Hyderabad, India: Universities Press, 2008.
4. A. A. Deshpande and O. G. Kakde, *C and Data Structures*. New Delhi, India: Dreamtech Press, 2004.

### Reference books:

1. M. T. Goodrich, R. Tamassia, and D. M. Mount, *Data Structures and Algorithms in C++*, 2nd ed. Hoboken, NJ, USA: Wiley, 2011.
2. R. Thareja, *Data Structures Using C*, 3rd ed. New Delhi, India: Oxford University Press, 2023.
3. M. A. Weiss, *Data Structures and Algorithm Analysis in C*, 2nd ed. Upper Saddle River, NJ, USA: Pearson Education, 2002.
4. R. K. Arora, *Optimization: Algorithms and Applications*. Boca Raton, FL, USA: Chapman & Hall/CRC Press, 2015.

### Online References:

1. Swayam Course: [https://swayam.gov.in/nd1\\_noc19\\_cs47/preview](https://swayam.gov.in/nd1_noc19_cs47/preview)
2. Mooc Course: <https://www.mooc-list.com/tags/algorithms>
3. Coursera Course: <https://www.coursera.org/specializations/algorithms>

### Course Assessment:

#### ISE:

- To be conducted in any of these forms - Assignment/ Quiz/ Presentation/ Class Test/ Case study etc. of 20 marks.
- ISE 20 marks = 05 marks for attendance + 15 marks for activities.

#### MSE:

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### End Semester Examination:

**\$ ESE of duration 03 hours are of 80 marks and scaled to 60.**

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2. Question 1(20 marks): - Solve any 04 out of 06. All questions carry 05 marks each.
3. Question 2 (40 marks): - Solve any 04 out of 06. All questions carry 10 marks each.
4. Question 3(20 marks):- Solve any 04 out of 06. All questions carry 05 marks each.
5. All COs should be mapped as per the weightage in the syllabus.

| Course Code | Course Name             | Teaching Scheme (Hrs.) |           |          | Credits Assigned |           |          |       |
|-------------|-------------------------|------------------------|-----------|----------|------------------|-----------|----------|-------|
|             |                         | Theory                 | Practical | Tutorial | Theory           | Practical | Tutorial | Total |
| MDM C5062   | Supply Chain Management | 03                     | --        | 01       | 03               | --        | 01       | 04    |

| Course Code | Course Name             | Examination Scheme |     |                   |      |       |       |
|-------------|-------------------------|--------------------|-----|-------------------|------|-------|-------|
|             |                         | Theory Marks       |     |                   | CIAP | ESEP  | Total |
|             |                         | Course Assessment  |     | ESE <sup>\$</sup> |      |       |       |
|             |                         | ISE                | MSE |                   |      |       |       |
| MDM C5062   | Supply Chain Management | 20                 | 20  | 60                | 25   | ----- | 125   |

**Pre- requisite:**

1. Basic MS Excel.

**Program Outcomes Addressed**

1. PO1: Engineering Knowledge
2. PO2: Problem Analysis
3. PO7: Global and Ethical Practices
4. PO8: Collaborative Teamwork
5. PO9: Communication
6. PO11: Lifelong Learning

**Course Objectives:**

1. To introduce the fundamental concepts, components, and processes of supply chain management in manufacturing and service sectors.
2. To develop understanding of demand forecasting, inventory management, procurement, and logistics as core elements of SCM.
3. To equip students with the ability to analyze supply chain networks, evaluate performance, and identify improvement opportunities.
4. To familiarize students with supply chain technologies such as ERP systems, RFID, IoT, and analytics tools.
5. To build decision-making skills related to sourcing, production planning, transportation, and distribution strategies.
6. To promote awareness of sustainability, risk management, and global challenges in supply chain operations.

**Course Outcomes: Learners will be able**

1. To explain key supply chain, logistics, and international shipping concepts.
2. To apply analytical tools to solve basic warehousing, transportation, and network design problems.
3. To analyze supply chain flows and identify performance gaps, risks, and integration challenges.
4. To evaluate supply chain efficiency using cost, service, sustainability, and responsiveness metrics.
5. To design technology-enabled and resilient supply chain solutions for domestic and global environments.
6. To demonstrate understanding of sustainable, ethical, and technology-enabled supply chain practices and assess their impact on organizational performance.

| Module No. | Unit No. | Topics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Hrs.      | CO              |
|------------|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|-----------------|
| <b>1.0</b> | <b>1</b> | <b>Module 1: Introduction to Supply Chain, Logistics and International Shipping</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>09</b> |                 |
|            |          | Introduction to Supply Chain, Decision Phases in a Supply Chain, Linkages and Decisions in SCM.<br>Process and Cycle View of a Supply Chain.<br>Supply Chain Models: Efficient Chain, Responsive Supply Chain and Agile Models.<br>Importance of supply chain flows.<br>Logistics and Shipping: functions. Objectives, Goals, Decisions. 1st Party, 2nd Party, 3rd Party, 4th Party Logistic service provider<br>Introduction to International Shipping: Freight Forwarders, shipping documents, Ports and customs, Incoterms<br>Reverse Logistics.                   |           | <b>CO1, CO2</b> |
|            |          | Self-learning Topics: Importance of supply chain flows. Logistics and Shipping: functions. Objectives, Goals, Decisions                                                                                                                                                                                                                                                                                                                                                                                                                                               |           |                 |
| <b>2.0</b> | <b>2</b> | <b>Warehousing and Transportation</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>09</b> |                 |
|            |          | Warehouse: role, type, functions.<br>Warehouse location modelling: methods such as COG, MCOG, and the LP approach.<br>Layout design, Space calculation,<br>Warehouse automation, Hub and Spoke Model, WMS<br>Distribution, Role, Importance, Levels, Channels, Structure, Functions. Channel partners, functions.<br>Infrastructure, road, rail, air, water, pipeline. Freight Management, Freight cost. Transportation Network Route Planning, Containerization, and Packing. Effective / Cost Optimising strategies.<br>Cross-docking, Milk run, and transshipment. |           | <b>CO2, CO3</b> |
|            |          | Self-learning Topics: Role, Importance, Levels, Channels, Structure, Functions. Channel partners, functions.                                                                                                                                                                                                                                                                                                                                                                                                                                                          |           |                 |
| <b>3.0</b> |          | <b>Performance Measurement and Controls in Supply Chain Management</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>03</b> |                 |
|            |          | Supply Chain Cost Calculations<br>Supply Chain Reliability & Responsiveness<br>Supply Chain Asset Management: cash to cash cycle, return on working capital & working capital<br>Analytics Framework Based on SCOR Model                                                                                                                                                                                                                                                                                                                                              |           | <b>CO3, CO4</b> |
|            |          | Self-learning Topics: Concepts of Supply Chain Asset Management: cash to cash cycle & working capital                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |           |                 |

**SIES Graduate School of Technology**  
**Department of Computer Science and Engineering**  
**(Internet of Things and Cyber Security including Blockchain Technology)**  
**Bachelor of Engineering**

|            |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |           |                     |
|------------|--|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|---------------------|
| <b>4.0</b> |  | <b>Designing a network in a supply chain</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>06</b> |                     |
|            |  | <p>Network design in the supply chain</p> <p>Alternate channels in distribution</p> <p>Location decisions in the supply chain using Excel</p> <p>Role and factors affecting network designing</p> <p>Network Optimisation Model</p> <p>Network design in an uncertain environment</p> <p>Flexibility in Supply Chain</p> <p>Practical problems using Excel</p>                                                                                                                                                                                                                                                                                                                              |           | <b>CO2, CO4 CO5</b> |
|            |  | Self-learning Topics: Role and factors affecting network designing                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |           |                     |
| <b>5.0</b> |  | <b>Supply Chain Integration and Designing Global Supply Chain Networks</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>06</b> |                     |
|            |  | <p>Bullwhip effect, Collaborative Planning Forecasting Replenishment (CPRF) concept. Inventory Management and Risk Pooling, Strategic Alliances, Retailer-Supplier Partnerships: Types, Requirements, and Inventory Ownership.</p> <p>Outsourcing and related decisions</p> <p>Global Market: Technological/ Cost/ Political, and Economic Forces. Risks and Advantages of the International Supply Chain.</p> <p>International versus Regional products.</p> <p>Local autonomy versus central control.</p> <p>Regional differences in Logistics- Cultural differences/ infrastructure/ performance expectation, and evaluation, Information systems availability, and human resources.</p> |           | <b>CO3, CO5</b>     |
|            |  | Self-learning Topics: Concepts related to Outsourcing and related decisions, Risks and Advantages of the International Supply Chain.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |           |                     |
| <b>6.0</b> |  | <b>Ethical issues in Supply Chain and Technological Trends in Supply Chain</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <b>06</b> |                     |
|            |  | <p>Supply chain vulnerability.</p> <p>Conformance to applicable laws such as Contract and commercial laws, Trade regulation, government procurement regulations, patents, Copyrights, trademark laws, transportation and logistics laws and regulations</p> <p>Environmental laws. International practices. Confidentiality and proprietary information.</p> <p>Functional application of technologies in Supply Chain: Blockchain, AI, IOT, RFID, AR, VR, ERP</p> <p>Goldratt Supply Chains, Sustainable Supply Chain, Resilient supply chains, Green Supply chain, Lean supply chain.</p>                                                                                                 |           | <b>CO4, CO5</b>     |
|            |  | <b>Self-learning Topics:</b> Concepts of Blockchain, AI, IOT, RFID, AR, VR, ERP                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |           |                     |
|            |  | <b>Tutorial on application of supply chain management concepts in excel</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |           |                     |
|            |  | <b>Total</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>39</b> |                     |

**Textbooks:**

1. Supply Chain Management: Strategy, Planning, and Operation, 6th Edition, Sunil Chopra & Peter Meindl, Pearson Education

**Reference books:**

1. Supply Chain Analytics and Modelling: Quantitative Tools and Applications, 1st Edition, Kogan Page
2. Supply Chain Logistics Management, 2nd Edition, Bowersox, Donald J, 2014, McGraw Hills.
3. Supply Chain Management: The Basics & Beyond, Copacino, William C, 1997, ST. Lucie Press.
4. Logistics and Supply Chain Management, Martin Christopher

**Online References:**

1. <https://www.emerald.com/ijlm>: Emerald Jurnoul
2. <https://www.emeraldgrouppublishing.com/journal/scm>: Emerald Jurnoul

**Course Assessment:**

**ISE:**

- To be conducted in any of these forms - Assignment/ Quiz/ Presentation/ Class Test/ Case study etc. of 20 marks.
- ISE 20 marks = 05 marks for attendance + 15 marks for activities.

**MSE:**

- To be conducted as written examination for 20 marks (on 40% - 50% syllabus)

**End Semester Examination:**

**\$ ESE of duration 03 hours are of 80 marks and scaled to 60.**

1. Question paper will comprise of 03 questions.
2. Question1(20 marks): - Solve any 04 out of 06. All questions carry 05 marks each.
3. Question 2 (40 marks): - Solve any 04 out of 06. All questions carry 10 marks each.
4. Question3(20 marks):- Solve any 04 out of 06. All questions carry 05 marks each.
5. All COs should be mapped as per the weightage in the syllabus.

**CIAP ( 25-Marks = Tutorial 20 Marks + Attendance 5 Marks ):**

Tutorials will be class wise and shall include real-world supply chain cases using Excel. Hands-on Excel-based exercises to be conducted in the computer laboratory.

| Course Code        | Course Name                   | Teaching Scheme (Hrs.) |           |           | Credits Assigned |           |           |           |
|--------------------|-------------------------------|------------------------|-----------|-----------|------------------|-----------|-----------|-----------|
|                    |                               | Theory                 | Practical | Tutorial  | Theory           | Practical | Tutorial  | Total     |
| <b>CSEPEC 5011</b> | <b>IoT Systems Processors</b> | <b>03</b>              | <b>--</b> | <b>--</b> | <b>03</b>        | <b>--</b> | <b>--</b> | <b>03</b> |

| Course Code | Course Name            | Examination Scheme         |     |                  |      |      |       |
|-------------|------------------------|----------------------------|-----|------------------|------|------|-------|
|             |                        | The <sup>1</sup> ory Marks |     |                  | CIAP | ESEP | Total |
|             |                        | Course Assessment          |     | ESE <sup>s</sup> |      |      |       |
|             |                        | ISE                        | MSE |                  |      |      |       |
| CSEPEC 5011 | IoT Systems Processors | 20                         | 20  | 60               | --   | --   | 100   |

**Pre-requisite:**

1. CSEC 304: Digital Logic and Computer Organisation and Architecture.
2. CSEC 405: Microprocessor.

**Program Outcomes addressed:**

1. PO1: Engineering knowledge.
2. PO2: Problem analysis.
3. PO3: Design/ Development of solution.
4. PO4: Conduct Investigations of Complex Problems.
5. PO5: Engineering Tool Usage.
6. PO6: The Engineer and the world.
7. PO11: Life-long Learning.

**Course Objectives:**

1. To understand IoT architecture, hardware, and software ecosystem.
2. To analyze IoT processors and their interfacing capabilities.
3. To explore wireless communication protocols and edge computing frameworks.
4. To integrate cloud, AI, and data analytics within IoT systems.
5. To examine security, power optimization, and industrial standards for IoT deployment.
6. To prepare students for IoT hardware design and prototype development aligned with current industry practices.

**Course Outcomes: Learners will be able to**

1. Describe IoT architecture, layers, and applications in smart environments.
2. Explain and analyze architectures of IoT processors and controllers (ESP32, STM32, Raspberry Pi).
3. Demonstrate sensor/actuator interfacing techniques for IoT data acquisition and control.
4. Evaluate wired/wireless communication protocols and networking models for IoT.
5. Implement cloud integration, edge computing, and AI-based data processing for IoT systems.
6. Design and analyze complete IoT solutions for real-world problems considering performance and security.

| Module No. | Unit No.   | Topics                                                                                                                                                                                                                                     | Hrs.      | CO         |
|------------|------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|------------|
| <b>1.0</b> |            | <b>Introduction to IoT</b>                                                                                                                                                                                                                 | <b>04</b> |            |
|            | <b>1.1</b> | <b>Introduction to IoT:</b> Definition of Io, Physical Design and Logical Design of IoT.                                                                                                                                                   |           | <b>CO1</b> |
|            | <b>1.2</b> | <b>IoT Architecture:</b> functional blocks of IoT, communication models, APIs, wireless sensor networks.                                                                                                                                   |           |            |
|            |            | <b>Self-Learning:</b> Arduino family.                                                                                                                                                                                                      |           |            |
| <b>2.0</b> |            | <b>IoT Processor and Microcontrollers</b>                                                                                                                                                                                                  | <b>08</b> |            |
|            | <b>2.1</b> | <b>Overview of Microcontrollers:</b> Overview of 8-bit/16-bit microcontrollers (8051, PIC, AVR, MSP430, ESP32, STM32), difference between microcontroller and microprocessor and SoC.                                                      |           | <b>CO2</b> |
|            | <b>2.2</b> | <b>IoT Processors:</b> Role of processors in IoT systems, Raspeberry pi, ARM-Cortex-M4, Nvidia Jetson, x86 - Architecture, GPIO, timers, PWM, ADC/DAC, communication interfaces.                                                           |           |            |
|            |            | <b>Self-Learning:</b> Programming Environment Arduino IDE, MicroPython.                                                                                                                                                                    |           |            |
| <b>3.0</b> |            | <b>Sensors, Actuators and Interfacing</b>                                                                                                                                                                                                  | <b>08</b> |            |
|            | <b>3.1</b> | <b>Sensors:</b> Definition, classification, working principle, architecture, and types of sensors.                                                                                                                                         |           | <b>CO3</b> |
|            | <b>3.2</b> | <b>Actuators:</b> Definition, working principle, Types of Actuators, Properties, Decision Properties.                                                                                                                                      |           |            |
|            | <b>3.3</b> | <b>Interfacing and Control Techniques:</b> Interfacing actuators using driver circuits (L293D, ULN2003, MOSFET-based drivers), Pulse Width Modulation (PWM) control via microcontrollers, Closed-loop control using sensors and actuators. |           |            |
|            |            | <b>Self-Learning:</b> Use of inbuilt ADC/DAC in Arduino, ESP32, and Raspberyy Pi.                                                                                                                                                          |           |            |
| <b>4.0</b> |            | <b>Communication and Networking for IoT</b>                                                                                                                                                                                                | <b>08</b> |            |
|            | <b>4.1</b> | <b>Wired protocols:</b> UART, SPI, I2C<br><b>Wireless protocols:</b> Wi-Fi, Bluetooth, BLE, ZigBee, LoRa, GSM, NB-IoT MQTT, CoAP, and REST-based APIs, PWM generation and demodulation.                                                    |           | <b>CO4</b> |
|            | <b>4.2</b> | <b>IoT Device &amp; Network Security:</b> CIA triad in IoT, Secure boot, firmware verification, hardware root of trust, Encryption, authentication, replay-attack protection, Secure OTA updates, credential security.                     |           |            |

|            |            |                                                                                                                                                                                              |           |            |
|------------|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|------------|
|            |            | <b>Self-Learning:</b> SPI thermometer, I2C thermometer, DTH11, Frequency counters.                                                                                                           |           |            |
| <b>5.0</b> |            | <b>Cloud, Edge Computing, and Data Analytics</b>                                                                                                                                             | <b>07</b> |            |
|            | <b>5.1</b> | <b>Cloud platforms:</b> AWS IoT Core, Azure IoT Hub, Google Firebase, ThingSpeak. Data pipelines and dashboard visualization Edge computing, TinyML, and AI integration at the device level. |           | <b>CO5</b> |
|            | <b>5.2</b> | Innovative Applications with the Internet of Things, Benefits of Cloud Platforms.                                                                                                            |           |            |
|            |            | <b>Self-Learning:</b> Cloud Trends and IoT Integration                                                                                                                                       |           |            |
| <b>6.0</b> |            | <b>Hands-on Projects IoT</b>                                                                                                                                                                 | <b>04</b> |            |
|            | <b>6.1</b> | Industry 4.0 concepts, DIY kits- soil moisture monitoring, weather monitoring, Air quality monitoring, movement detection                                                                    |           | <b>CO6</b> |
|            | <b>6.2</b> | Use cases: Smart cities, IoT, autonomous vehicles                                                                                                                                            |           |            |
|            |            | <b>Self-Learning:</b> health monitoring                                                                                                                                                      |           |            |
|            |            | <b>Total</b>                                                                                                                                                                                 | <b>39</b> |            |

#### Textbooks:

1. Raj Kamal, *Internet of Things: Architecture and Design Principles*, McGraw Hill, 2017, ISBN-13: 978-93-526052244.
2. Arshdeep Bahga & Vijay Madisetti, *Internet of Things: A Hands-on Approach*, Universities Press, 2017, ISBN: 9788173719547
3. Adrian McEwen & Hakim Cassimally, *Designing the Internet of Things*, Wiley, ISBN: 978-1-118-43062-0.
4. Donald Norris, *The Internet of Things: Do-It-Yourself Projects*, McGraw Hill, ISBN: 978-0-07-183521-3
5. Shriram K. Vasudevan, Abhishek S. Nagarajan, RMD Sundaram, *Internet of Things*, Wiley India, 2019, ISBN: 978-8126578375.

#### Reference books:

1. Sergey Y. Yurish, *Digital Sensors and Sensor Systems: Practical Design*, 2011, 1st ed., IFSA publishing, New York, 1st Edition, 2011, ISBN: 978-8461430864
2. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, *IoT Fundamentals Networking Technologies, Protocols, and Use Cases for the Internet of Things*, CISCO. ISBN: 978-1587144561
3. Maciej Kranz, *Building the Internet of Things: Implement New Business Models, Disrupt Competitors, Transform Your Industry*, Wiley, 2016, ISBN: 978-1119285687.
4. Pethuru Raj, Anupama C. Raman, *The Internet of Things: Enabling Technologies, Platforms, and Use Cases*, CRC Press, ISBN: 978-1498778510.

### Online References

1. Raspberry Pi Documentation: <https://www.raspberrypi.com/documentation/>
2. ESP32 Docs & SDK: <https://docs.espressif.com/>
3. AWS IoT Core Tutorials: <https://aws.amazon.com/iot-core/>
4. Google Cloud IoT Core: <https://cloud.google.com/solutions/iot>
5. <https://owasp.org/www-project-internet-of-things/>
6. NPTEL: Sudip Misra, IIT Khargpur, Introduction to IoT: Part-1, <https://nptel.ac.in/courses/106/105/106105166/>
7. NPTEL: Prof. Prabhakar, IISc Bangalore, Design for Internet of Things, [https://onlinecourses.nptel.ac.in/noc21\\_ee85/preview](https://onlinecourses.nptel.ac.in/noc21_ee85/preview)

### Free IoT simulation tools:

1. Wokwi IoT Simulator: <https://wokwi.com>
2. Tinkercad Circuits: <https://www.tinkercad.com/circuits>
3. Cisco Packet Tracer IoT Mode: <https://www.netacad.com>

### Course Assessment

#### ISE:

- To be conducted in any of these forms - Assignment/ Quiz/ Presentation/ Class Test/ Case study etc. of 20 marks.
- ISE 20 marks = 05 marks for attendance + 15 marks for activities.

#### MSE:

- To be conducted as written examination for 20 marks (on 40% - 50% syllabus).

### End Semester Examination:

**\$ ESE of duration 03 hours are of 80 marks and scaled to 60.**

1. Question paper will comprise 03 questions.
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5. All COs should be mapped as per the weightage in the syllabus.

| Course Code  | Course Name                | Teaching Scheme (Hrs.) |           |          | Credits Assigned |           |          |       |
|--------------|----------------------------|------------------------|-----------|----------|------------------|-----------|----------|-------|
|              |                            | Theory                 | Practical | Tutorial | Theory           | Practical | Tutorial | Total |
| CSEPE C 5012 | Cryptocurrency and Bitcoin | 03                     | -         | -        | 03               | -         | -        | 03    |

| Course Code | Course Name                | Examination Scheme |     |       |      |      |       |
|-------------|----------------------------|--------------------|-----|-------|------|------|-------|
|             |                            | Theory Marks       |     |       | CIAP | ESEP | Total |
|             |                            | Course Assessment  |     | ESE\$ |      |      |       |
|             |                            | ISE                | MSE |       |      |      |       |
| CSEPEC 5012 | Cryptocurrency and Bitcoin | 20                 | 20  | 60    | --   | --   | 100   |

**Pre-requisite:**

1. CSEC303 - Discrete Structure and Automata Theory

**Program Outcomes addressed:**

1. PO1: Engineering Knowledge
2. PO2: Problem Analysis
3. PO6: The Engineer and The World
4. PO7: Ethics
5. PO11: Life-Long Learning

**Course Objectives:**

1. To explain cryptocurrencies, blockchain technology, and basic cryptography.
2. To explain crypto-asset investments, ICOs, and Altcoin technologies.
3. To describe global cryptocurrency regulations and compliance requirements.
4. To understand and apply the concepts of keys, wallets, and transactions in the Bitcoin Network.
5. To provide students with a comprehensive understanding of Bitcoin network architecture, node operations, and mining processes.
6. To help students understand anonymity and security concepts in cryptocurrency systems.

**Course Outcomes: Learners will be able to**

1. Explain the fundamentals of cryptocurrencies, blockchain, and basic cryptographic primitives.
2. Evaluate the functioning of crypto assets, altcoins, and ICOs.
3. Analyze cryptocurrency regulations and compliance practices.
4. Explain the concepts of keys, wallets, and transactions in the Bitcoin network.
5. Evaluate Bitcoin network architecture, transaction propagation, and mining mechanisms.
6. Analyze anonymity, pseudonymity, and security principles in cryptocurrency systems.

| Module No. | Unit No.   | Topics                                                                                                                                                                                                                                                                                                                                                                   | Hrs.      | CO         |
|------------|------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|------------|
| <b>1.0</b> |            | <b>Introduction to Cryptocurrencies</b>                                                                                                                                                                                                                                                                                                                                  | <b>07</b> |            |
|            | <b>1.1</b> | Crypto assets, How cryptocurrency transactions work? Properties and Main Characteristics of Cryptocurrencies, Link between Blockchain and cryptocurrencies, Simple Cryptocurrencies: Goofy Coin, Scrooge Coin, Altcoins, Stable coins and its types.                                                                                                                     |           | <b>CO1</b> |
|            | <b>1.2</b> | <b>Basic Crypto primitives:</b> Hash Functions, Cryptographic Hash functions and its properties, Hashing Algorithms-SHA-256, Merkle trees, Symmetric Key and Asymmetric key Cryptography, ECC, Digital Signatures-ECDSA, Random Number Generators, Zero-knowledge proofs                                                                                                 |           |            |
|            |            | <b>Self-Learning:</b> Digital currencies, virtual currencies, CBDC                                                                                                                                                                                                                                                                                                       |           |            |
| <b>2.0</b> |            | <b>Crypto Asset Ecosystem: Investment, ICOs, and Altcoin</b>                                                                                                                                                                                                                                                                                                             | <b>06</b> |            |
|            | <b>2.1</b> | <b>Investing in crypto assets-</b> Mining, Exchanges, Wallets and Pricing, Risks and Mitigation.                                                                                                                                                                                                                                                                         |           | <b>CO2</b> |
|            | <b>2.2</b> | <b>ICO:</b> What are ICO's, Working, Token sale, ICO funding stages, Whitelisting, Funding caps, Treasury, Exchange Listing.                                                                                                                                                                                                                                             |           |            |
|            | <b>2.3</b> | <b>Altcoins:</b> Relation between Altcoin and Bitcoin, Merge mining, Atomic cross chain swaps, Bitcoin-Backed Altcoins.                                                                                                                                                                                                                                                  |           |            |
|            |            | <b>Self-Learning:</b> Different types of Altcoins, ETF                                                                                                                                                                                                                                                                                                                   |           |            |
| <b>3.0</b> |            | <b>Cryptocurrency Regulations</b>                                                                                                                                                                                                                                                                                                                                        | <b>05</b> |            |
|            | <b>3.1</b> | Cryptocurrency Regulation: Importance of regulations in cryptocurrency, Role of cryptocurrencies in financing Illicit activities, AML and KYC Compliance in Cryptocurrencies, Regulatory landscape for trading platforms, Compliance practices for Security Exchanges, Compliance consideration in using an creating crypto wallets, Role of FATF in crypto regulations. |           | <b>CO3</b> |
|            |            | <b>Self-Learning:</b> Crypto Taxes, Privacy coins and regulatory Challenges.                                                                                                                                                                                                                                                                                             |           |            |
| <b>4.0</b> |            | <b>Concepts of Bit coin</b>                                                                                                                                                                                                                                                                                                                                              | <b>10</b> |            |
|            | <b>4.1</b> | <b>Keys and Addresses:</b> Public keys, Private keys, Bitcoin Addresses-IP addresses, Legacy Addresses, Bech32 Addresses, Bech32m addresses, Mult signature Addresses.                                                                                                                                                                                                   |           | <b>CO4</b> |
|            | <b>4.2</b> | <b>Wallets and Wallet Recovery:</b> Non-deterministic wallets, Deterministic wallets, Hierarchical Deterministic wallets, Brain wallet, Paper Wallet, Online Wallet, BIP-39,32 and 44.                                                                                                                                                                                   |           |            |
|            | <b>4.3</b> | <b>Transactions:</b> Getting your first bit coin, finding the current price of Bitcoin, sending and receiving bitcoin, Serialized bitcoin Transaction, Coinbase transactions, Transaction fees, Transaction scripts and scripting language, Turing Incompleteness,                                                                                                       |           |            |

|            |            |                                                                                                                                                                                                                          |           |            |
|------------|------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|------------|
|            |            | Stateless Verification, Script Construction,                                                                                                                                                                             |           |            |
|            |            | <b>Self-Learning:</b> Base58check Encoding, Compressed public keys, Vanity Addresses                                                                                                                                     |           |            |
| <b>5.0</b> |            | <b>Bitcoin Networks and Mining</b>                                                                                                                                                                                       | <b>07</b> |            |
|            | <b>5.1</b> | <b>Bitcoin Networks:</b> Bitcoin Relay Networks, Network Discovery, Full Nodes, exchanging “Inventory”, Lightweight Clients, Bloom Filters, How lightweight client uses bloom filters? Meme Pools and Transaction pools. |           | <b>CO5</b> |
|            | <b>5.2</b> | <b>Bitcoin mining:</b> The task of Bitcoin miners, Mining Hardware, Energy consumption and ecology, Mining Pools, Mining Incentives and strategies. Alternative Mining Puzzles                                           |           |            |
|            |            | <b>Self-Learning:</b> Compact Block Filters                                                                                                                                                                              |           |            |
| <b>6.0</b> |            | <b>Bitcoin Security</b>                                                                                                                                                                                                  | <b>04</b> |            |
|            | <b>6.1</b> | <b>Anonymity:</b> Definition, Anonymity versus Pseudonymity, Unlinkability, Why Anonymity Is Needed, Anonymization versus Decentralization                                                                               |           | <b>CO6</b> |
|            | <b>6.2</b> | <b>Security:</b> Security Principles, Developing Bitcoin Systems Securely, The root of Trust, User Security best practices                                                                                               |           |            |
|            |            | <b>Self-Learning:</b> How to Deanonimize Bitcoin, Study technical papers based on bitcoin security                                                                                                                       |           |            |
|            |            | <b>Total</b>                                                                                                                                                                                                             | <b>39</b> |            |

#### Textbooks:

1. A. M. Antonopoulos, *Mastering Bitcoin: Programming the Open Blockchain*, 3rd ed. O'Reilly Media, 2023
2. A. Narayanan, J. Bonneau, E. Felten, A. Miller, and S. Goldfeder, *Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction*, 1st ed. Princeton University Press, 2016.
3. I. Bashir, *Mastering Blockchain: Distributed Ledger Technology, Decentralization and Smart Contracts Explained*, 4<sup>th</sup> ed. Packt Publishing, 2023.
4. N. Daskalakis and P. Georgitseas, *An Introduction to Cryptocurrencies: The Crypto Market Ecosystem*, 1st ed. Routledge, 2021
5. B. Williams, *Cryptocurrency Compliance: Demystifying Regulations and Ensuring Compliance in the World of Cryptocurrency*, 1st ed. Wiley, 2022.

#### Reference books:

1. D. Tapscott and A. Tapscott, *Blockchain Revolution: How the Technology Behind Bitcoin is Changing Money, Business and the World*, 1st ed. Portfolio Penguin, 2016.
2. M. Grabowski, *Cryptocurrencies: A Primer on Digital Money*, 1st ed. Routledge, 2019.
3. E. Rodriguez, *Cryptocurrency Regulation Trends*, Cham, Switzerland: Springer, 2021.
4. B. Williams, *Cryptocurrency Compliance: Demystifying Regulations and Ensuring Compliance in the World of Cryptocurrency*, 1st ed. Hoboken, NJ, USA: Wiley, 2022.

**Online References:**

1. Blockchain Demo <https://andersbrownworth.com/blockchain/>
2. Blockchain Demo: Public/Private Keys and Digital Signatures: <https://andersbrownworth.com/blockchain/public-private-keys/>
3. Coursera Course: <https://www.coursera.org/learn/cryptocurrency>
4. CoinMarketCap: <https://coinmarketcap.com/>
5. CryptoCompare: <https://www.cryptocompare.com/>

**ISE:**

- To be conducted in any of these forms - Assignment/ Quiz/ Presentation/ Class Test/ Case study etc. of 20 marks
- ISE 20 marks=05 marks for attendance + 15 marks for activities

**MSE:**

- To be conducted as written examination for 20 marks (on 40% -50% syllabus).

**End Semester Examination:**

**\$ ESE of duration 03 hours are of 80 marks and scaled to 60**

1. Question paper will comprise 03 questions.
2. Question1(20 marks): - Solve any 04 out of 06. All questions carry 05 marks each.
3. Question 2 (40 marks): - Solve any 04 out of 06. All questions carry 10 marks each.
4. Question 3 (20 marks): - Solve any 04 out of 06. All questions carry 05 marks each.
5. All COs should be mapped as per the weightage in the syllabus.

| Course Code        | Course Name             | Teaching Scheme (Hrs.) |           |           | Credits Assigned |           |           |           |
|--------------------|-------------------------|------------------------|-----------|-----------|------------------|-----------|-----------|-----------|
|                    |                         | Theory                 | Practical | Tutorial  | Theory           | Practical | Tutorial  | Total     |
| <b>CSEPEC 5013</b> | <b>Malware Analysis</b> | <b>03</b>              | <b>--</b> | <b>--</b> | <b>03</b>        | <b>--</b> | <b>--</b> | <b>03</b> |

| Course Code | Course Name      | Examination Scheme |     |                   |      |      |       |
|-------------|------------------|--------------------|-----|-------------------|------|------|-------|
|             |                  | Theory Marks       |     |                   | CIAP | ESEP | Total |
|             |                  | Course Assessment  |     | ESE <sup>\$</sup> |      |      |       |
|             |                  | ISE                | MSE |                   |      |      |       |
| CSEPEC 5013 | Malware Analysis | 20                 | 20  | 60                | --   | --   | 100   |

**Pre-requisite:**

1. CSEC403: Computer Network
2. CSEC402: Operating Systems

**Program Outcomes Addressed:**

1. PO1: Engineering Knowledge
2. PO2: Problem Analysis
3. PO3: Design/ Development of Solutions
4. PO6: The Engineer and the World
5. PO7: Ethics
6. PO11: Life-Long Learning

**Course Objectives:**

1. To introduce the fundamentals of malware analysis and malware taxonomy.
2. To apply basic static analysis techniques for identifying and classifying malware.
3. To perform advanced static analysis using disassembly and reverse-engineering tools.
4. To conduct advanced dynamic analysis through debugging, monitoring, and sandboxing.
5. To understand core malware functionalities such as persistence, credential stealing, and process injection.
6. To analyze malware obfuscation and de-obfuscation techniques.

**Course Outcomes: Learners will be able to**

1. Identify various malwares and understand the behavior of malwares in real world applications.
2. Implement different malware analysis techniques.
3. Understand the fundamental principles of static malware analysis and its importance in cybersecurity.
4. Apply advanced dynamic analysis techniques to analyze sophisticated malware threats
5. Assess of malware functionality and the tools and techniques.
6. Examine advanced obfuscation methods.

| Module No. | Unit No.   | Topics                                                                                                                                                                                                                                                                                                                 | Hrs.      | CO         |
|------------|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|------------|
| <b>1.0</b> |            | <b>Introduction and Basic Analysis</b>                                                                                                                                                                                                                                                                                 | <b>07</b> |            |
|            | <b>1.1</b> | Malware Analysis: Introduction, Techniques, Types of malwares, General rules for Malware Analysis, Framework and Phases of Malware analysis.                                                                                                                                                                           |           | <b>CO1</b> |
|            | <b>1.2</b> | Malware Taxonomy, Malware Attack Life Cycle, The Combat Teams, Anti-malware Products, Reverse Engineering for Windows and Linux systems.                                                                                                                                                                               |           |            |
|            |            | <b>Self-Learning:</b> Evolution of Malware Over the Last Decade.                                                                                                                                                                                                                                                       |           |            |
| <b>2.0</b> |            | <b>Basic Static Techniques</b>                                                                                                                                                                                                                                                                                         | <b>06</b> |            |
|            | <b>2.1</b> | Antivirus Scanning, Hashing, Finding Strings, Packed and Obfuscated Malware, Portable Executable Malware.                                                                                                                                                                                                              |           | <b>CO2</b> |
|            | <b>2.2</b> | Portable executable File Format, Linked Libraries and Functions, Static Analysis, The PE file headers and sections.                                                                                                                                                                                                    |           |            |
|            | <b>2.3</b> | YARA Rules for Malware Classification & Detection.                                                                                                                                                                                                                                                                     |           |            |
|            |            | <b>Self-Learning:</b> Comparative Study of Antivirus Scanning Techniques (Signature, Heuristic, Behavioral).                                                                                                                                                                                                           |           |            |
| <b>3.0</b> |            | <b>Advanced Static Analysis</b>                                                                                                                                                                                                                                                                                        | <b>08</b> |            |
|            | <b>3.1</b> | The Stack, Conditionals, Branching, Rep Instructions, Disassembly, Global and local variables, Arithmetic operations, Loops, Function Call Conventions, C Main Method and Offsets, AI-based pattern recognition in disassembly.                                                                                        |           | <b>CO3</b> |
|            | <b>3.2</b> | Portable Executable File Format, The PE File Headers and Sections, IDA Pro, Function analysis, Graphing, The Structure of a Virtual Machine, Analyzing Windows programs, Antistatic analysis techniques, obfuscation, packing, metamorphism, polymorphism.                                                             |           |            |
|            |            | <b>Self-Learning:</b> Analyzing Code Optimization Techniques and Their Effects on Disassembly.                                                                                                                                                                                                                         |           |            |
| <b>4.0</b> |            | <b>Advanced Dynamic Analysis</b>                                                                                                                                                                                                                                                                                       | <b>08</b> |            |
|            | <b>4.1</b> | Live malware analysis, dead malware analysis, analyzing traces of malware, system calls, API calls, registries, network activities(Network logs, diagnosing network logs, extracting severity from network behavior) Anti-dynamic analysis techniques, VM detection techniques, Evasion techniques, , Malware Sandbox. |           | <b>CO4</b> |
|            | <b>4.2</b> | Monitoring with Process Monitor, Packet Sniffing with Wireshark, Kernel vs. User-Mode Debugging, OllyDbg, Breakpoints, Tracing, Exception Handling, Patching                                                                                                                                                           |           |            |
|            |            | <b>Self-Learning:</b> Behavioral Analysis Using Sandboxes (Cuckoo, Any.Run, Hybrid Analysis).                                                                                                                                                                                                                          |           |            |

|            |            |                                                                                                                                                                                                                                                   |           |            |
|------------|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|------------|
|            |            |                                                                                                                                                                                                                                                   |           |            |
| <b>5.0</b> |            | <b>Malware Functionality</b>                                                                                                                                                                                                                      | <b>06</b> |            |
|            | <b>5.1</b> | Downloaders and Launchers, Backdoors, Credential Stealers, Persistence Mechanisms, Handles, Mutexes, Privilege Escalation,                                                                                                                        |           | <b>CO5</b> |
|            | <b>5.2</b> | Covert malware launching, Launchers, Process Injection, Process Replacement, Hook Injection, Detours, APC injection. Threat intelligence & management, Management of threats, Severity evaluation of malware.                                     |           |            |
|            |            | <b>Self-Learning:</b> Case Studies of Real-World Malware (WannaCry, Stuxnet, Zeus, Emotet).                                                                                                                                                       |           |            |
| <b>6.0</b> |            | <b>Obfuscation Techniques</b>                                                                                                                                                                                                                     | <b>04</b> |            |
|            | <b>6.1</b> | File Obfuscation , Binary Obfuscation Techniques, Assembly of data, Encrypted data identification ,Decrypting with x86dbg ,Control flow flattening obfuscation, Garbage code insertion - Dynamic library loading and Anti-obfuscation techniques. |           | <b>CO6</b> |
|            |            | <b>Self-Learning:</b> Code Virtualization as an Advanced Obfuscation Method.                                                                                                                                                                      |           |            |
|            |            | <b>Total</b>                                                                                                                                                                                                                                      | <b>39</b> |            |

**Text books:**

1. A. Mohanta and A. Saldanha, Malware Analysis and Detection Engineering: A Comprehensive Approach to Detect and Analyze Modern Malware, 1st ed. United States: Apress, 2020.
2. S. Oriyano and M. Solomon, Hacker Techniques, Tools, and Incident Handling, 3rd ed. Burlington, MA, USA: Jones & Bartlett Learning, 2020.
3. M. Sikorski and A. Honig, Practical Malware Analysis, San Francisco, CA, USA: No Starch Press, 2012.
4. A. Kleymentov and A. Thabet, Mastering Malware Analysis, Birmingham, UK: Packt Publishing, 2019.
5. M. Monnappa K. A., Learning Malware Analysis, 2nd ed. Birmingham, U.K.: Packt Publishing, 2023.

**Reference books:**

1. J. Butler and G. Hoglund, Rootkits: Subverting the Windows Kernel, Boston, MA, USA: Addison-Wesley Professional, 2005.
2. B. Dang, A. Gazet, E. Bachaalany, and S. Josse, Practical Reverse Engineering: x86, x64, ARM, Windows Kernel, Reversing Tools, and Obfuscation, Hoboken, NJ, USA: Wiley, 2014.
3. V. Marak, Windows Malware Analysis Essentials, Birmingham, UK: Packt Publishing, 2015.
4. K. Dunham, S. Hartman, M. Quintans, J. A. Morales, and T. Strazzere, Android Malware and Analysis, Boca Raton, FL, USA: CRC Press, Taylor & Francis Group, 2015.

**Online Resources:**

1. Coursera Course: <https://www.coursera.org/learn/malware-analysis-and-assembly>
2. SANS Institute: <https://www.sans.org/>
3. NPTEL Course: <https://nptel.ac.in/courses/106106129>
4. Coursera Course: <https://www.coursera.org/professional-certificates/ibm-cybersecurity-analyst>
5. Google Course: <https://www.coursera.org/professional-certificates/google-cybersecurity>
6. OWASP Foundation: <https://owasp.org/>

**Course Assessment:**

**ISE:**

- To be conducted in any of these forms - Assignment/ Quiz/ Presentation/ Class Test/ Case study etc. of 20 marks.
- ISE 20 marks = 05 marks for attendance + 15 marks for activities.

**MSE:**

- To be conducted as written examination for 20 marks (on 40% - 50% syllabus).

**End Semester Examination:**

**\$ ESE of duration 03 hours is of 80 marks and scaled to 60.**

1. Question paper will comprise of 03 questions.
2. Question 1 (20 marks): - Solve any 04 out of 06. All questions carry 05 marks each.
3. Question 2 (40 marks): - Solve any 04 out of 06. All questions carry 10 marks each.
4. Question 3 (20 marks): - Solve any 04 out of 06. All questions carry 05 marks each.
5. All COs should be mapped as per the weightage in the syllabus.

| Course Code        | Course Name                         | Teaching Scheme (Hrs.) |           |          | Credits Assigned |           |          |           |
|--------------------|-------------------------------------|------------------------|-----------|----------|------------------|-----------|----------|-----------|
|                    |                                     | Theory                 | Practical | Tutorial | Theory           | Practical | Tutorial | Total     |
| <b>CSEPEC 5014</b> | <b>Data ware housing and Mining</b> | <b>03</b>              | <b>-</b>  | <b>-</b> | <b>03</b>        | <b>-</b>  | <b>-</b> | <b>03</b> |

| Course Code | Course Name                  | Examination Scheme |     |       |      |      |       |
|-------------|------------------------------|--------------------|-----|-------|------|------|-------|
|             |                              | Theory Marks       |     |       | CIAP | ESEP | Total |
|             |                              | Course Assessment  |     | ESE\$ |      |      |       |
|             |                              | ISE                | MSE |       |      |      |       |
| CSEPEC 5014 | Data ware housing and Mining | 20                 | 20  | 60    | --   | --   | 100   |

**Pre-requisite:**

1. CSEC302: Data Structures and Algorithms
2. CSEC304: Database Management System

**Program Outcomes Addressed:**

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO3: Design/Development of Solutions
4. PO4: Conduct investigations of complex problems
5. PO11: Life-Long Learning

**Course Objectives:**

1. To identify the significance of Data Warehousing and Mining.
2. To develop understanding of various data preprocessing and data exploration techniques for knowledge discovery.
3. To analyse data, choose relevant models and choose classification or clustering algorithms for respective applications.
4. To study web data mining.
5. To develop research interest towards advances in data mining.
6. To enable students to apply appropriate data mining techniques for solving real-world problems.

**Course Outcomes: Learners will be able to**

1. Design data warehouse with dimensional modelling and apply OLAP operations.
2. Apply Data preprocessing and Visualization.
3. Classify real-world problems using appropriate classification algorithms.
4. Identify the need of clustering in real world scenario and apply the same.
5. Analyse Association rules to identify frequent patterns.
6. Describe complex information and social networks with respect to web mining.

| Module No. | Unit No.   | Topics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Hrs.      | CO         |
|------------|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|------------|
| <b>1.0</b> |            | <b>Datawarehouse fundamentals and Online Analytical Processing</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>08</b> |            |
|            | <b>1.1</b> | Data Structures and Algorithms, Database management systems concepts, Introduction to Data Warehouse, Data warehouse architecture, Data warehouse versus Data Marts, Data Warehouse Schemas; Star Schema, Snowflake Schema, Factless Fact Table, Fact Constellation Schema, Update to the dimension tables. Major steps in ETL process, Data cube modelling, OLAP operations:<br>Slice, Dice, Rollup, Drilldown and Pivot.<br><b>Self-Learning:</b> Cloud-based data warehouses, Use cases of DW in IoT, finance, healthcare, retail, telecom. |           | <b>CO1</b> |
| <b>2.0</b> |            | <b>Introduction to Data Mining, Data Exploration and Data Pre-processing</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>08</b> |            |
|            | <b>2.1</b> | Data Mining Task Primitives, KDD process, Applications of Data Mining, Data Preprocessing: summarization, Cleaning, Data Integration & transformation, Data Reduction: Attribute subset selection, Histograms, Clustering and Sampling, Data Discretization: Normalization, Binning, Histogram Analysis and Concept hierarchy generation.                                                                                                                                                                                                      |           | <b>CO2</b> |
|            | <b>2.2</b> | Statistical Description of Data, Data Exploration: Types of Attributes, Proximity Measures for Nominal Attributes and Binary Attributes, Dissimilarity of Numeric Data, Types of Learning: supervised and unsupervised learning.<br><b>Self-Learning:</b> Data Visualization, Explore BI tools: Power BI, Tableau.                                                                                                                                                                                                                             |           |            |
| <b>3.0</b> |            | <b>Classification</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>08</b> |            |
|            | <b>3.1</b> | Basic Concepts; Classification methods: 1. Decision Tree Induction: Attribute Selection Measures, ID3 algorithm 2. Naïve Bayes classification, 3. K-Nearest neighbor, Model evaluation and selection Accuracy and Error measures, Precision, Recall, F1-score, Confusion matrix etc.<br>Evaluating the Accuracy of a Classifier: Holdout & Random Subsampling, Cross Validation, Bootstrap.<br><b>Self-Learning:</b> Ensemble methods bagging, boosting, random forest                                                                         |           | <b>CO3</b> |
| <b>4.0</b> |            | <b>Clustering Analysis</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>05</b> |            |
|            | <b>4.1</b> | Types of data in Cluster analysis, Partitioning Methods (k-Means, k-Medoids), Hierarchical Methods (Agglomerative, Divisive), Density based clustering: DBSCAN algorithm<br><b>Self-Learning:</b> Advanced clustering algorithms BIRCH, CLIQUE, Case studies on Clustering for customer segmentation and Classification for medical diagnosis.                                                                                                                                                                                                 |           | <b>CO4</b> |

| 5.0 |     | Association Rules mining                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 06        |     |
|-----|-----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|-----|
|     | 5.1 | Market Basket Analysis, Frequent Item sets, Closed Item sets, and Association Rule, Frequent Pattern Mining, Apriori Algorithm, Association Rule Generation, Improving the Efficiency of Apriori, Frequent Pattern Growth Algorithm, Introduction to Mining Multilevel Association Rules and Mining Multidimensional Association Rules.<br><b>Self-Learning:</b> Constraint-based mining, Use of association mining in: Healthcare, IoT device telemetry and Cybersecurity |           | CO5 |
| 6.0 |     | Web Mining                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 04        |     |
|     | 6.1 | Introduction, Web Content Mining: Crawlers, Personalization, Web Structure Mining: Page Rank, HITS or Clever, Web Usage Mining.<br><b>Self-Learning:</b> API-based data extraction, Real-world case studies on Google Search Ranking, Amazon product recommendation and YouTube video ranking                                                                                                                                                                              |           | CO6 |
|     |     | <b>Total</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>39</b> |     |

#### Text Books:

1. P. Ponniah, Data Warehousing: Fundamentals for IT Professionals, 1st ed. Wiley India, 2010.
2. J. Han, M. Kamber, and J. Pei, Data Mining: Concepts and Techniques, 3rd ed. Morgan Kaufmann, 2011.
3. M. H. Dunham, Data Mining: Introductory and Advanced Topics, 1st ed. Pearson Education, 2002.

#### References:

1. R. Theraja, Data Warehousing, 1st ed. Oxford University Press, 2009.
2. P.-N. Tan, M. Steinbach, and V. Kumar, Introduction to Data Mining, 2nd ed. Pearson, 2018.
3. I. H. Witten, E. Frank, and M. A. Hall, Data Mining: Practical Machine Learning Tools and Techniques, 4th ed., Cambridge, MA, USA: Morgan Kaufmann, 2016.

#### Online Resources

1. SWAYAM Course: [https://onlinecourses.swayam2.ac.in/imb25\\_mg200/preview](https://onlinecourses.swayam2.ac.in/imb25_mg200/preview)
2. NPTEL Course: [https://onlinecourses.nptel.ac.in/noc21\\_cs06/preview](https://onlinecourses.nptel.ac.in/noc21_cs06/preview)
3. NPTEL Course: [https://onlinecourses.nptel.ac.in/noc20\\_cs12/preview](https://onlinecourses.nptel.ac.in/noc20_cs12/preview)

#### Course Assessment:

##### ISE:

- To be conducted in any of these forms - Assignment/ Quiz/ Presentation/ Class Test/ Case study etc. of 20 marks.
- ISE 20 marks = 05 marks for attendance + 15 marks for activities

##### MSE:

- To be conducted as written examination for 20 marks (on 40% - 50% syllabus)

**End Semester examination:**

**\$ ESE of duration 03 hours are of 80 marks and scaled to 60.**

1. Question paper will comprise of 03 questions.
2. Question 1 (20 marks): - Solve any 04 out of 06. All questions carry 05 marks each.
3. Question 2 (40 marks): - Solve any 04 out of 06. All questions carry 10 marks each.
4. Question 3 (20 marks): - Solve any 04 out of 06. All questions carry 05 marks each.
5. All COs should be mapped as per the weightage in the syllabus.

| Course Code | Course Name                           | Teaching Scheme (Hrs.) |           |          | Credits Assigned |           |          |       |
|-------------|---------------------------------------|------------------------|-----------|----------|------------------|-----------|----------|-------|
|             |                                       | Theory                 | Practical | Tutorial | Theory           | Practical | Tutorial | Total |
| CSEL501     | Cryptography and Network Security Lab | --                     | 02        | --       | --               | 01        | -        | 01    |

| Course Code | Course Name                           | Examination Scheme |     |                  |      |      |       |
|-------------|---------------------------------------|--------------------|-----|------------------|------|------|-------|
|             |                                       | Theory Marks       |     |                  | CIAP | ESEP | Total |
|             |                                       | Course Assessment  |     | ESE <sup>s</sup> |      |      |       |
|             |                                       | ISE                | MSE |                  |      |      |       |
| CSEL501     | Cryptography and Network Security Lab | --                 | --  | --               | 25   | 25   | 50    |

**Pre-requisite:**

1. CSEL402: Computer Network Lab

**Program Outcomes Addressed:**

1. PO2: Problem Analysis
2. PO3: Design/Development of Solutions
3. PO4: Conduct investigations of complex problems
4. PO5: Engineering tool usage
5. PO7: Ethics
6. PO11: Lifelong learning

**Lab Objectives:**

1. To apply the knowledge of symmetric cryptography to implement classical ciphers.
2. To analyze and implement public key encryption algorithms, hashing and digital signature algorithms.
3. To explore the different network reconnaissance tools to gather information about networks.
4. To explore the tools like sniffers, port scanners and other related tools for analyzing.
5. To Scan the network for vulnerabilities and simulate attacks.
6. To set up intrusion detection systems using open-source technologies and to explore email security.

**Lab Outcomes:**

Upon completion of this course, learners will be able to:

1. Illustrate symmetric cryptography by implementing classical ciphers.
2. Demonstrate Key management, distribution and user authentication.
3. Examine the different network reconnaissance tools to gather information about networks.
4. Use tools like sniffers, port scanners and other related tools for analyzing packets in a network.
5. Use open-source tools to scan the network for vulnerabilities and simulate attacks.
6. Demonstrate the system and network security mechanism using open-source tools.

| <b>Suggested List of Experiments:</b> Students are required to complete at least 12 experiments. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |           |
|--------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| <b>Sr. No.</b>                                                                                   | <b>Title of Experiments</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>LO</b> |
| 1                                                                                                | A small startup developing a secure messaging application for internal communication has identified that using a single classical encryption technique is insufficient to protect sensitive data from basic cryptanalysis attacks. To enhance security, the development team decides to implement a <b>product cipher</b> that combines a substitution cipher (to alter the characters of the message) and a transposition cipher (to rearrange their positions).            | LO1       |
| 2                                                                                                | A fintech company needs to ensure secure transactions by providing confidentiality, authentication, and data integrity. Students must implement the <b>RSA cryptosystem</b> for encryption/decryption and a digital signature scheme using <b>RSA digital signature</b> or <b>ElGamal digital signature scheme</b> .                                                                                                                                                         | LO2       |
| 3                                                                                                | A company requires a secure method for remote employees to establish a shared secret key over an insecure network without directly transmitting it. Students must implement the <b>Diffie-Hellman key exchange</b> to simulate how two parties generate a common secret using public parameters. The system should demonstrate key exchange and analyze its effectiveness against eavesdropping attacks.                                                                     | LO2       |
| 4                                                                                                | A cloud-based file storage service needs to ensure that files uploaded and downloaded by users remain unaltered during transmission and storage, even when handling data of varying sizes such as text files, images, and large documents. To achieve this, the development team decides to implement message integrity verification using hash functions like <b>MD5</b> and <b>SHA-1</b> through standard cryptographic APIs.                                              | LO2       |
| 5                                                                                                | A secure data storage and transmission system used by an enterprise needs to protect large volumes of sensitive information, such as documents and logs, from unauthorized access. Since encrypting long messages directly with a single method may expose patterns or vulnerabilities, the development team decides to use block cipher modes of operation with algorithms like <b>Advanced Encryption Standard</b> or <b>Data Encryption Standard</b> to enhance security. | LO2       |
| 6                                                                                                | A cybersecurity team is conducting a preliminary security assessment of a web application by gathering publicly available network information such as domain details, DNS records, IP addresses, and network paths. Students are required to use tools like <b>WHOIS</b> , <b>dig</b> , <b>traceroute</b> , and <b>nslookup</b> to analyze this data and understand the network structure.                                                                                   | LO3       |
| 7                                                                                                | A network administrator investigates unusual activity by capturing and analyzing real-time traffic using <b>Wireshark</b> . Students must capture ICMP, TCP, and HTTP packets in promiscuous mode and apply filters to trace specific traffic.                                                                                                                                                                                                                               | LO3       |
| 8                                                                                                | A cybersecurity analyst is tasked with assessing the security posture of an organization's network by identifying open ports, active hosts, and potential vulnerabilities. Students are required to install and use <b>Nmap</b> with various options to perform ping scans, TCP/UDP port scans, OS fingerprinting, and advanced scans like Xmas scan.                                                                                                                        | LO4       |
| 9                                                                                                | A network administrator suspects a <b>ARP spoofing attack</b> disrupting communication within a local network. Students are required to detect such attacks using tools like <b>Nmap</b> , <b>Arpwatch</b> , and <b>Wireshark</b> , while generating gratuitous ARP packets using <b>arping</b> .                                                                                                                                                                            | LO4       |
| 10                                                                                               | A network security team needs to understand how denial-of-service attacks can disrupt system availability and degrade network performance. Students are required to simulate a controlled DoS attack using tools like <b>hping</b> and <b>hping3</b> to generate high volumes of traffic.                                                                                                                                                                                    | LO5       |

|    |                                                                                                                                                                                                                                                                                                                                                   |     |
|----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| 11 | A cybersecurity team is assessing system vulnerabilities and potential malware threats within an organization's network. Students are required to use <b>Nessus</b> or <b>Kali Linux</b> to scan for security weaknesses, and study a keylogger attack using a controlled tool to understand how sensitive information can be captured.           | LO5 |
| 12 | A company deploying an IoT-based smart system (such as home automation or healthcare monitoring) needs to ensure secure communication and protection of sensitive data from cyber threats. Students are required to design a case study on IoT security, analyzing potential vulnerabilities, threats, and protection mechanisms in such systems. | LO6 |
| 13 | An organization aims to secure its internal network communication and detect potential intrusions in real time. Students are required to configure <b>IPsec</b> on Linux to establish secure communication channels and set up <b>Snort</b> to monitor network traffic and analyze logs.                                                          | LO6 |
| 14 | An organization needs to secure its email communication to ensure confidentiality and authenticity of sensitive information exchanged between employees. Students are required to explore and use <b>GNU Privacy Guard</b> on Linux to encrypt, decrypt, and digitally sign emails.                                                               | LO6 |
| 15 | An organization needs to ensure that employees' access only the resources required for their job roles to maintain security and prevent unauthorized actions. Students are required to implement <b>Role-Based Access Control</b> by creating users, assigning roles, and defining permission sets to control access to system resources.         | LO6 |

#### Textbooks:

1. W. Stallings, Cryptography and Network Security: Principles and Practice, 8th ed., Boston, MA, USA: Pearson, 2024.
2. B. A. Forouzan, Cryptography and Network Security, Revised ed. New Delhi, India: Tata McGraw-Hill, 2011.
3. B. L. Menezes and R. Kumar, Cryptography, Network Security, and Cyber Laws, 1st ed. New Delhi, India: Cengage Learning, 2018.
4. E. Cole, Network Security Bible, 2nd ed. Hoboken, NJ, USA: Wiley, Mar. 2011.
5. W. Stallings and L. Brown, Computer Security: Principles and Practice, 5th ed., Boston, MA, USA: Pearson, 2024.

#### Reference books:

1. M. Gregg, Build Your Own Security Lab: A Field Guide for Network Testing, 1st ed. Indianapolis, IN, USA: Wiley, 2008.
2. T. Boyles, CCNA Security Study Guide: Exam 640-553, 1st ed. Hoboken, NJ, USA: Wiley/Sybex, 2010.
3. D. Stuttard and M. Pinto, The Web Application Hacker's Handbook: Finding and Exploiting Security Flaws, 2nd ed. Hoboken, NJ, USA: Wiley, 2011.

#### Online Resources:

1. Wireshark: <https://www.wireshark.org/download.html>
2. Nmap: <https://nmap.org/>
3. Tenable Nessus: Vulnerability Scanner: <https://www.tenable.com/products/nessus>
4. Virtual Lab: <https://cse29-iiith.vlabs.ac.in/>
5. CrypTool-Online: Interactive Cryptography Learning Tool: <https://www.cryptool.org/en/cto/>
6. Dcode Tool: <https://www.dcode.fr/en>

**Term Work:**

- The term work shall include a total of 12 experiments (Ensure that all the LOs are covered). Term work will be assessed as Continuous Internal Assessment Practical (CIAP).

**Term work Marks (CIAP):**

- 25 Marks (Total Marks) = 20 Marks (Experiments) + 05 Marks (Attendance).
- The final certification and acceptance of term work ensure satisfactory performance of laboratory work and minimum passing marks in term work.

**Oral Exam: (2 hours/ 25 Marks)**

- End-semester oral exam will be held based on the above syllabus and will be conducted as End Semester Examination Practical (ESEP).

| Course Code | Course Name                                     | Teaching Scheme (Hrs.) |           |          | Credits Assigned |           |          |       |
|-------------|-------------------------------------------------|------------------------|-----------|----------|------------------|-----------|----------|-------|
|             |                                                 | Theory                 | Practical | Tutorial | Theory           | Practical | Tutorial | Total |
| CSEL502     | Software Engineering and Project Management Lab | --                     | 02        | --       | --               | 01        | --       | 01    |

| Course Code | Course Name                                     | Examination Scheme |     |     |      |      |       |
|-------------|-------------------------------------------------|--------------------|-----|-----|------|------|-------|
|             |                                                 | Theory Marks       |     |     | CIAP | ESEP | Total |
|             |                                                 | Course Assessment  |     | ESE |      |      |       |
|             |                                                 | ISE                | MSE |     |      |      |       |
| CSEL502     | Software Engineering and Project Management Lab | --                 | --  | --  | 25   | --   | 25    |

**Per-requisite:**

1. FEL205: Object Oriented Programming Methodology Lab
2. CSEL403: Skill Lab- Web Technology

**Program Outcomes Addressed:**

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO3: Design/Development of Solutions
4. PO4: Conduct investigations of complex problems
5. PO5: Engineering Tool Usage
6. PO9: Communication
7. PO10: Project Management and Finance
8. PO11: Life-Long Learning

**Lab Objectives:**

1. To familiarize students with project documentation tools such as Jira, Confluence, and Draw.io.
2. To enable students to prepare software requirement documents following IEEE standards.
3. To help students interpret and create UML and DFD-based design models for a software project.
4. To train students in project scheduling, estimation, and risk analysis techniques.
5. To provide hands-on experience in version control using Git and GitHub.
6. To build skills in applying software testing techniques, including White Box, Black Box, and TDD.

**Lab Outcomes:**

Upon completion of this course, Learners will be able to:

1. Set up project management and documentation tools using Jira, Confluence, and Git.
2. Prepare structured software requirement documents and problem statements.
3. Construct UML diagrams and process models for a software project.

4. Apply project estimation, scheduling, and risk management techniques.
5. Use version control operations, Docker containerization, and DevOps practices for managing project artifacts and deployments.
6. Design, develop, and execute software test cases using White Box, Black Box, and TDD methodologies.

**Suggested List of Experiments:** Students are required to complete at least 12 experiments.

| Sr. No. | Title of Experiments                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | LO  |
|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| 1       | a) Set up project management and documentation environment for SEPM lab experiments.<br>b) A metropolitan city plans to build an intelligent traffic management system integrated with emergency services (ambulance, fire, police). It Currently facing problems like Severe traffic congestion, Delayed emergency response, No real-time coordination between departments. The city wants a data-driven, AI-powered platform to optimize traffic and save lives. Prepare detailed statement of problems for this project and identify suitable process model for the same with justification. | LO1 |
| 2       | Develop a Software Requirements Specification (SRS) document in accordance with IEEE standards for the project introduced in Lab 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                             | LO2 |
| 3       | Identify scenarios & develop UML Use case and Class Diagram for the project introduced in Lab 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | LO3 |
| 4       | Draw DFD (up to 2 levels) and prepare Data Dictionary for the project introduced in Lab 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | LO3 |
| 5       | Develop Activity / State Transition diagram for the project introduced in Lab 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | LO3 |
| 6       | Develop Sequence and Collaboration diagram for the project introduced in Lab 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | LO3 |
| 7       | Prepare schedule and estimation for the project introduced in Lab 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | LO4 |
| 8       | Prepare RMMM plan for the project introduced in Lab 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | LO4 |
| 9       | Perform version control operations: <ul style="list-style-type: none"> <li>• Set up repository</li> <li>• Create local repository</li> <li>• Implement change control: commit, revert, version history</li> <li>• Create and manage branches</li> <li>• Merge branches and resolve conflicts</li> <li>• Perform local and remote repository operations</li> </ul>                                                                                                                                                                                                                               | LO5 |
| 10      | Set up containerization environment and execute basic container operations.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | LO5 |
| 11      | Develop and containerize a simple application: <ul style="list-style-type: none"> <li>• Create a basic application</li> <li>• Write a container configuration file</li> <li>• Build a container image</li> <li>• Run the application inside a container</li> <li>• Access the application through terminal or browser</li> </ul>                                                                                                                                                                                                                                                                | LO5 |

|    |                                                                                                                                                                                                                                                                                                                                                            |            |
|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| 12 | Implement container image management and version control integration: <ul style="list-style-type: none"> <li>• Tag container images</li> <li>• Push and pull images from a repository</li> <li>• Integrate containerized application with version control system</li> <li>• Maintain versioned container images for project builds and releases</li> </ul> | <b>LO5</b> |
| 13 | Develop test cases for a program using White Box and Basis Path Testing for project.                                                                                                                                                                                                                                                                       | <b>LO6</b> |
| 14 | Design and execute test cases using Control Structure and Black Box Testing techniques.                                                                                                                                                                                                                                                                    | <b>LO6</b> |
| 15 | Implement Test-Driven Development (TDD) for a small application.                                                                                                                                                                                                                                                                                           | <b>LO6</b> |

#### Textbooks:

1. Roger S. Pressman, *Software Engineering: A Practitioner's Approach*, 9th Edition, McGraw- Hill Education, 2023.
1. Ian Sommerville, *Software Engineering*, 10th Edition, Pearson Education, 2026.
2. Ugrasen Suman, *Software Engineering: Concepts and Practices*, Cengage Learning, 2<sup>nd</sup> edition 2022.

#### Reference books:

1. Ali Behfrooz and Fredeick J. Hudson, "Software Engineering Fundamentals", Oxford University Press, 2<sup>nd</sup> edition, 2007.
2. Pankaj Jalote, "An integrated approach to Software Engineering", Narosa, 2005
3. Jibitesh Mishra and Ashok Mohanty, "Software Engineering", Pearson, 2011
4. Rajib Mall, "Fundamentals of Software Engineering", Prentice Hall India, 2018

#### Online References:

1. NPTEL Course: [https://onlinecourses.swayam2.ac.in/cec21\\_cs21/preview](https://onlinecourses.swayam2.ac.in/cec21_cs21/preview)
2. NPTEL Course: <https://nptel.ac.in/courses/106101061>

#### Software Tools:

1. Jira
2. Confluence
3. Draw.io/StarUML
4. MS Project / GanttProject
5. Git, GitHub
6. Docker Desktop / Docker Engine

#### Term Work:

- Term work should consist of at least **12 experiments**. Term work will be assessed as Continuous Internal Assessment Practical (CIAP).

#### Term work Marks (CIAP):

- 25 Marks (Total Marks) = 20 Marks (Experiment) + 05 Marks (Attendance).
- The final certification and acceptance of term work ensure satisfactory performance of laboratory work and minimum passing marks in term work.

**SIES Graduate School of Technology**  
**Department of Computer Science and Engineering**  
**(Internet of Things and Cyber Security including Blockchain Technology)**  
**Bachelor of Engineering**

| Course Code | Course Name               | Teaching Scheme (Hrs.) |           |          | Credits Assigned |           |          |       |
|-------------|---------------------------|------------------------|-----------|----------|------------------|-----------|----------|-------|
|             |                           | Theory                 | Practical | Tutorial | Theory           | Practical | Tutorial | Total |
| CSEL503     | Blockchain Technology Lab |                        | 2         | -        | -                | 01        | -        | 01    |

| Course Code | Course Name               | Examination Scheme |     |       |      |      |       |
|-------------|---------------------------|--------------------|-----|-------|------|------|-------|
|             |                           | Theory Marks       |     |       | CIAP | ESEP | Total |
|             |                           | Course Assessment  |     | ESE\$ |      |      |       |
|             |                           | ISE                | MSE |       |      |      |       |
| CSEL503     | Blockchain Technology Lab |                    |     |       | 25   | 25   | 50    |

**Pre-requisite:**

1. FEL205 - Object Oriented Programming Methodology Lab
2. CSEL403 - Skill Lab - Web Technology

**Program Outcomes addressed:**

1. PO1: Engineering knowledge.
2. PO2: Problem analysis.
3. PO3: Design/ Development of solution
4. PO4: Conduct Investigations of Complex Problems
5. PO5: Engineering Tool Usage
6. PO6: The Engineer and The World
7. PO7: Ethics
8. PO8: Individual and Collaborative Team work
9. PO9: Communication
10. PO10: Project Management & Finance
11. PO11: Life-Long Learning

**Lab Objectives:**

1. To develop and deploy smart contracts on local Blockchain.
2. To deploy smart contracts on test networks.
3. To develop and test smart contracts using Remix IDE and MetaMask.
4. To construct a permissioned Hyperledger fabric network.
5. To design and develop cryptocurrency.
6. To develop and test a DApp using Ethereum/Hyperledger.

**Lab Outcomes:**

**Upon completion of the course, learners will be able to:**

1. Develop and test smart contracts on local Blockchain.
2. Develop and test smart contracts on Ethereum test networks.
3. Write and deploy smart contracts using Remix IDE and MetaMask.
4. Write and deploy chain code in Hyperledger Fabric.
5. Design and develop Cryptocurrency.
6. Develop a Full-fledged DApp using Ethereum/Hyperledger.

**SIES Graduate School of Technology**  
**Department of Computer Science and Engineering**  
**(Internet of Things and Cyber Security including Blockchain Technology)**  
**Bachelor of Engineering**

| <b>Sr. No.</b> | <b>Module</b>                                                                        | <b>Detailed Content</b>                                                                                                                                                                                                | <b>LO Mapping</b> |
|----------------|--------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| 1              | Local Blockchain and smart contracts                                                 | Introduction to Truffle, establishing local Blockchain using Truffle, Solidity programming language, chain code (Java/JavaScript/Go), deployment on Truffle local Blockchain.<br>Mini Project: Allocation of the group | LO1               |
| 2              | Deployment and publishing smart contracts on Ethereum test network                   | Ethereum Test networks, deployment on test networks, Web3.js/Web3.py for interaction with Ethereum smart contract.<br>Mini Project: Topic validation and finalizing software requirements                              | LO2               |
| 3              | Remix IDE and MetaMask                                                               | Smart contract development and deployment using MetaMask and Remix.<br>Mini Project: Study the required programming language for smart contract/chain code                                                             | LO3               |
| 4              | Chaincode deployment in Hyperledger Fabric                                           | Chain code deployment in Hyperledger Fabric.<br>Mini project: Study required front end tools                                                                                                                           | LO4               |
| 5              | Crypto currency Design                                                               | Design and develop Crypto currency Mini Project: Study Integration of front end with smart contract/chain code                                                                                                         | LO5               |
| 6              | Mini project on Design and Development of a DApps using Ethereum/ Hyperledger Fabric | Implementation of Mini Project<br>1.Design, configure and testing of mini project<br>2.Report submission as per guidelines                                                                                             | LO6               |

**Suggested List of Experiments:**

(Students are required to complete at least 09 experiments and Mini Project)

| Sr. No. | Title of Experiments                                                                                                                                                                                                                                                                                                                                            | LO  |
|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| 1       | Design and implement a local Ethereum blockchain environment using Truffle and Ganache. Develop and deploy a smart contract that stores and retrieves a numerical value. Demonstrate transaction execution and contract deployment using the local blockchain.                                                                                                  | LO1 |
| 2       | A college wants to conduct student elections in a secure and tamper-proof manner without relying on centralized systems. Design and implement a decentralized voting system using a local Ethereum blockchain setup with Truffle and Ganache.                                                                                                                   | LO1 |
| 3       | An academic institution wants to securely store student academic records in a tamper-proof manner. Develop a smart contract using Solidity that allows adding, updating, and retrieving student details (ID, name, marks). Ensure access control so only authorized users can modify records.                                                                   | LO2 |
| 4       | A developer needs to validate smart contract functionality in a real blockchain environment without financial risk. Deploy the previously developed student record smart contract on an Ethereum test network such as Sepolia Testnet. Configure wallet, acquire test Ether, and verify transactions using a blockchain explorer.                               | LO2 |
| 5       | A web application requires real-time interaction with a deployed smart contract. Develop a JavaScript-based interface using Web3.js to perform read and write operations on the deployed student contract. Display transaction results dynamically on the web interface.                                                                                        | LO2 |
| 6       | A beginner blockchain developer wants to quickly prototype and test smart contracts. Use Remix IDE to design, compile, and deploy a voting smart contract that allows users to vote for candidates and view results. Analyze gas usage and execution behavior.                                                                                                  | LO3 |
| 7       | A decentralized application requires secure user authentication and transaction signing. Integrate MetaMask with a voting smart contract deployed via Remix. Enable users to cast votes through MetaMask and observe transaction confirmation on the blockchain.                                                                                                | LO3 |
| 8       | A blockchain developer aims to reduce transaction costs while deploying smart contracts. Using Remix IDE, design two versions of a smart contract (e.g., one using inefficient storage vs optimized variables). Compare gas consumption for deployment and execution of both versions. Analyze how coding practices impact gas usage and propose optimizations. | LO3 |
| 9       | An enterprise organization requires a permissioned blockchain network for secure business transactions. Set up a basic network using Hyperledger Fabric with peers, orderers, and channels. Demonstrate network initialization and transaction flow.                                                                                                            | LO4 |
| 10      | A logistics company wants to track assets securely within an organization. Develop chaincode in Hyperledger Fabric to create updates, transfers, and query assets. Ensure that only authorized participants can modify asset ownership.                                                                                                                         | LO4 |
| 11      | A fintech startup aims to launch its own digital token for internal transactions. Design and implement an ERC-20 compliant cryptocurrency using Solidity that supports token creation, transfer, and balance checking. Test the token functionality on a local or test network.                                                                                 | LO5 |

|    |                                                                                                                                                                                                                                                                                                                                                                                                                    |     |
|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| 12 | A digital platform requires a flexible cryptocurrency that supports dynamic supply control. Design and implement an ERC-20 based token using Solidity that includes minting (creation of new tokens) and burning (removal of tokens) functionalities. Ensure that only authorized users (owner/admin) can perform these operations. Test token behavior including transfer, balance updates, minting, and burning. | LO5 |
| 13 | Mini Project based on the content of the syllabus (Group of 2-3 students)                                                                                                                                                                                                                                                                                                                                          | LO6 |

#### **Mini project:**

1. Students should carry out mini-project in a group of three/four students with a subject In-charge.
2. The group should meet with the concerned faculty during laboratory hours, and the progress of work discussed must be documented.
3. Each group should perform a detailed literature survey and formulate a problem statement.
4. Each group will identify the hardware and software requirements for their defined mini project problem statement.
5. Design, develop and test their smart contract/chain code.
6. Each group may present their work in various project competitions and paper presentations.

#### **Documentation of the Mini Project:**

The Mini Project Report can be made on following lines:

1. Abstract
2. Contents
3. List of figures and tables
4. Chapter 1 (Introduction, Literature survey, Problem definition, Objectives, Proposed Solution, Technology/platform used)
5. Chapter 2 (System design/Block diagram, Flow chart, Software requirements, cost estimation)
6. Chapter 3 (Implementation snapshots/figures with explanation, code, future directions)
7. Chapter 4 (Conclusion)
8. References

#### **Textbooks:**

- 1.M. Mukhopadhyay, *Ethereum Smart Contract Development*, Packt Publishing,2018
- 2.R. Modi, *Solidity Programming Essentials: A Beginner's Guide to Build Smart Contracts for Ethereum and Blockchain*,Packt Publishing,2018
- 3.M. Zand, X. Wu, and M. A. Morris, *Hands-on Smart Contract Development with Hyperledger Fabric V2*. O'Reilly,2021

#### **Reference books:**

1. Imran Bashir, *Mastering Blockchain*. Packt Publishing,2023
2. Chris Dannen, *Introducing Ethereum and Solidity*. APress,2017
3. N. Gaur, *Hands-on Blockchain with Hyperledger*. Packt Publishing,2018

#### **Online References:**

1. Truffle Suite Archive:<https://archive.trufflesuite.com/>
2. MetaMask:<https://metamask.io/>
3. Remix IDE:<https://remix.ethereum.org>
4. Hyperledger Fabric:<https://www.hyperledger.org/use/fabric>

**Term Work:**

- Term Work shall include a total of 9 experiments and Mini-Project (Ensure that all LO's are covered) on the above guidelines/syllabus.
- Journal must include Mini-Project report.
- The final certification and acceptance of Term work ensure satisfactory performance at laboratory work and minimum passing marks in Term work. Term work will be assessed as Continuous Internal Assessment Practical (CIAP).

**Term work Marks (CIAP):**

- 25 Marks (Total Marks) = 15 Marks (Experiment) + 05 Mark (Mini Project) + 05 Marks (Attendance)
- The final certification and acceptance of term work ensure satisfactory performance of laboratory work and minimum passing marks in term work.

**Oral Exam: (2 hours/ 25 Marks)**

- End semester oral exam will be held based on the above syllabus including Mini project and will be assessed as End Semester Examination Practical (ESEP).

| Course Code | Course Name                     | Teaching Scheme (Hrs.) |           |          | Credits Assigned |           |          |       |
|-------------|---------------------------------|------------------------|-----------|----------|------------------|-----------|----------|-------|
|             |                                 | Theory                 | Practical | Tutorial | Theory           | Practical | Tutorial | Total |
| CEL504      | Interpersonal and Career Skills | --                     | 2*+2      | --       | --               | 02        | --       | 02    |

| Course Code | Course Name                     | Examination Scheme |     |                   |      |      |       |
|-------------|---------------------------------|--------------------|-----|-------------------|------|------|-------|
|             |                                 | Theory Marks       |     |                   | CIAP | ESEP | Total |
|             |                                 | Course Assessment  |     | ESE <sup>\$</sup> |      |      |       |
|             |                                 | ISE                | MSE |                   |      |      |       |
| CEL504      | Interpersonal and Career Skills | -                  | -   | -                 | 50   | -    | 50    |

**Pre-requisite:**

FEC205: Professional Communication Techniques Course

**Program Outcome mapped:**

1. PO6: The Engineer and the World
2. PO7: Ethics
3. PO8: Individual and Collaborative Teamwork
4. PO9: Communication
5. PO10: Project Management & Finance
6. PO11: Lifelong Learning

**Course Objectives:** The course is designed:

1. To equip students with career development skills to align with the corporate and global requirements.
2. To develop students' ability to conduct and participate in professional business meetings.
3. To apply the knowledge of effective writing skills to produce technical/business documents.
4. To train students in creating effective, dynamic technical/business presentations.
5. To build strong interpersonal skills required for effective workplace communication.
6. To familiarise students with corporate ethics and Intellectual Property Rights.

**Course Outcomes**

After successful completion of the course, Learners will be able to:

1. Apply essential skills while appearing for recruitment processes or applying for higher education for a successful career.
2. Demonstrate professional behaviour; to plan, participate in, and document business meetings effectively.
3. Compose well-structured technical/business documents.
4. Design and deliver effective technical/business presentations using suitable strategies.

5. Employ strong interpersonal skills to overcome workplace challenges by understanding professional communication.
6. Practice principles of corporate ethics and understand Intellectual Property Rights.

| Module No. | Unit No.   | Topics                                                                                                                                                                        | Hrs.      | CO         |
|------------|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|------------|
| <b>1.</b>  |            | <b>Career Skills</b>                                                                                                                                                          | <b>08</b> |            |
|            | <b>1.1</b> | SWOT Analysis                                                                                                                                                                 |           | <b>CO1</b> |
|            | <b>1.2</b> | Cover letter, Resume/CV: Resume Building, Types of Resumes (Chronological, Functional & Combination), Curriculum Vitae, Difference between Resume and CV                      |           |            |
|            | <b>1.3</b> | Group Discussion: Purpose, Types of GDs (Normal, Case-based & Role Plays)                                                                                                     |           |            |
|            | <b>1.4</b> | GD Etiquettes, Parameters of Evaluating a GD                                                                                                                                  |           |            |
|            | <b>1.5</b> | Interviews (Face to face and Virtual): Planning and Preparation, Types of Questions, Types of Interviews (Structured, Stress, Behavioural, Problem Solving & Case-based)      |           |            |
|            | <b>1.6</b> | Modes of Interviews: Face-to-face, Telephonic                                                                                                                                 |           |            |
|            | <b>1.7</b> | Virtual Interview planning and preparation, Online interview etiquettes                                                                                                       |           |            |
|            | <b>1.8</b> | Statement of Purpose                                                                                                                                                          |           |            |
| <b>2.</b>  |            | <b>Business Meetings</b>                                                                                                                                                      | <b>03</b> |            |
|            | <b>2.1</b> | Documentation: Notice, Agenda, Minutes of the Meeting                                                                                                                         |           | <b>CO2</b> |
|            | <b>2.2</b> | Conducting Business Meetings: Types of Meetings, Roles and Responsibilities of Chairperson, Secretary and Members, Meeting Etiquettes                                         |           |            |
|            | <b>2.3</b> | Writing Minutes of the Meeting                                                                                                                                                |           |            |
| <b>3.</b>  |            | <b>Advanced Technical Writing</b>                                                                                                                                             | <b>06</b> |            |
|            | <b>3.1</b> | Purpose and Classification of Reports: Classification based on Subject Matter (Technology, Accounting, Finance, Marketing, etc.), Time Interval (Periodic, One-time, Special) |           | <b>CO3</b> |
|            | <b>3.2</b> | Function (Informational, Analytical, etc.), Physical Factors (Memorandum, Letter, Short & Long)                                                                               |           |            |
|            | <b>3.3</b> | Language and Style: Tense, Person & Voice of Reports, Numbering Style                                                                                                         |           |            |

|           |     |                                                                                                                                                                                         |           |            |
|-----------|-----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|------------|
|           |     | of Chapters, Sections and Figures/Tables, Proof-reading through Plagiarism Checkers                                                                                                     |           |            |
|           | 3.4 | Project Report:<br>Prefatory Parts (Front Matter), Report Proper (Main Body), Appended Parts (Back Matter)                                                                              |           |            |
|           | 3.5 | Proposals:<br>Format and Style of Technical Proposals, Parts of a Proposal                                                                                                              |           |            |
|           | 3.6 | Technical Paper Writing:<br>Parts of a Technical Paper, Language, Style and Formatting, Referencing in IEEE Format                                                                      |           |            |
| <b>4.</b> |     | <b>Effective Presentation</b>                                                                                                                                                           | <b>02</b> |            |
|           | 4.1 | Effective Presentation Strategies:<br>Defining purpose, analysing audience & location, Structuring a presentation, Types of presentation aids, Using body language and Voice modulation |           | <b>CO4</b> |
|           | 4.2 | Group Presentation:<br>Sharing Responsibility in a Team, Building the contents and visuals together, Transition Phases                                                                  |           |            |
| <b>5.</b> |     | <b>Interpersonal Skills</b>                                                                                                                                                             | <b>05</b> |            |
|           | 5.1 | Emotional Intelligence                                                                                                                                                                  |           | <b>CO5</b> |
|           | 5.2 | Leadership                                                                                                                                                                              |           |            |
|           | 5.3 | Time Management                                                                                                                                                                         |           |            |
|           | 5.4 | Decision Making                                                                                                                                                                         |           |            |
|           | 5.5 | Responsible Use of social media                                                                                                                                                         |           |            |
| <b>6.</b> |     | <b>Corporate Ethics and Intellectual Property Rights</b>                                                                                                                                | <b>02</b> |            |
|           | 6.1 | Introduction to Corporate Ethics                                                                                                                                                        |           | <b>CO6</b> |
|           | 6.2 | Intellectual Property Rights:<br>Copyrights, Trademarks, Patents, Industrial Designs, Geographical Indications, Integrated Circuits, Trade Secrets (Undisclosed Information)            |           |            |
|           |     | <b>Total</b>                                                                                                                                                                            | <b>26</b> |            |

**Reference books:**

1. J. Butterfield, *Professionalism : Soft Skills for a Digital Workplace*. Boston, Massachusetts: Cengage Learning, [] © Course Technology, Cengage Learning, 2011.
2. R. V. Lesikar and J. D. Petit, *Report Writing for Business*, 10th ed. McGraw-Hill/Irwin, 1995.
3. L. A. Olsen and T. N. Huckin, *Technical Writing and Professional Communication*,

- 2nd ed. McGraw-Hill Humanities, Social Sciences & World Languages, 1991.
4. L. Ann Masters and H. Wallace, *Personal Development for Life and Work.*, 12th ed. Mason, Oh: South-Western Cengage Learning, 2011.
  5. H. A. Murphy and Herbert William Hildebrandt, *Effective Business Communications*, 7th ed. McGraw-Hill Companies, 1988.
  6. F. Luthans, *Organization Behaviour*, 12th ed. New York: McGraw Hill, 2011.
  7. R. C. Sharma and K. Mohan, *Business Correspondence and Report Writing : A Practical Approach to Business & Technical Communication*, 6th ed. New Delhi: Tata McGraw-Hill, 2017.
  8. K. Alex, *Soft skills : Know yourself & know the world*, 3rd ed. New Delhi: S. Chand & Company Ltd, 2012.
  9. R Subramanian, *Professional ethics*, 2nd ed. New Delhi: Oxford University Press, 2013.
  10. S. Robbins and T. A. Judge, *Organisational Behaviour*, 18th ed. Pearson Higher Education AU, 2024.

**Online References:**

**1. Directorate General of Training (DGT).**

*Employability Skills Curriculum.* Ministry of Skill Development & Entrepreneurship, Government of India,  
[https://www.dgt.gov.in/sites/default/files/Employability\\_Skills\\_Curriculum.pdf](https://www.dgt.gov.in/sites/default/files/Employability_Skills_Curriculum.pdf).

**2. Punjab State Open University (PSOU).**

*Technical Writing and IPR Syllabus.* PSOU,  
[https://psou.ac.in/asset/docs/course\\_syllabus/20221125183033165f0acdb4.pdf](https://psou.ac.in/asset/docs/course_syllabus/20221125183033165f0acdb4.pdf).

**3. National Institute of Technology Kurukshetra (NITKKR).**

*Professional Ethics and Intellectual Property Rights (HSIR-13).* NITKKR,  
<https://nitkkar.ac.in/wp-content/uploads/2024/07/Professional-Ethics-and-IPR-HSIR-13.pdf>.

**4. Commonwealth Corporation.**

*Career Readiness Curriculum Guide.* CommCorp,  
[https://commcorp.org/wp-content/uploads/2016/07/resources\\_eyf-career-readiness-curriculum-guide.pdf](https://commcorp.org/wp-content/uploads/2016/07/resources_eyf-career-readiness-curriculum-guide.pdf).

**Course Assessment:**

Term Work (CIAP): **50 Marks**

Term Work (CIAP) shall consist of Oral & Written assessment for 25 marks each  
Oral evaluation to be conducted for **25 Marks** through:

- |                        |          |
|------------------------|----------|
| a) Report Presentation | 10 marks |
| b) Group Discussion    | 10 marks |
| c) Mock Interviews     | 05 marks |

Written evaluation to be conducted for **25 Marks** through:

- |                                     |          |
|-------------------------------------|----------|
| a) Project Report (25 to 30 pages)  | 10 marks |
| b) Assignments based on all modules | 10 marks |
| c) Attendance                       | 05 marks |

CIAP will be conducted based on the above scheme for **50 Marks**.

| Course Code | Course Name          | Teaching Scheme (Hrs.) |           |          | Credits Assigned |           |          |       |
|-------------|----------------------|------------------------|-----------|----------|------------------|-----------|----------|-------|
|             |                      | Theory                 | Practical | Tutorial | Theory           | Practical | Tutorial | Total |
| MDML5011    | Machine Learning Lab | --                     | 02        | --       | --               | 01        | --       | 01    |

| Course Code | Course Name          | Examination Scheme |     |     |      |      |       |
|-------------|----------------------|--------------------|-----|-----|------|------|-------|
|             |                      | Theory Marks       |     |     | CIAP | ESEP | Total |
|             |                      | Course Assessment  |     | ESE |      |      |       |
|             |                      | ISE                | MSE |     |      |      |       |
| MDML5011    | Machine Learning Lab | --                 | --  | --  | 25   | --   | 25    |

**Pre- requisite:**

1. ECC303: Skill Lab (Python Programming)

**Program Outcomes Addressed**

1. PO1: Engineering Knowledge
2. PO2: Problem Analysis
3. PO4: Conduct investigation of complex problem
4. PO5: Engineering tool usage
5. PO6: The Engineer and The World
6. PO7: Ethics
7. PO8: Individual and collaborative Team work
8. PO9: Communication

**Lab Objectives:**

1. To introduce Python libraries used for data analysis and machine learning.
2. To explain and perform data preprocessing, including cleaning, handling missing values, and feature scaling.
3. To implement supervised learning algorithms such as regression, classification, decision trees, SVM, and KNN.
4. To apply unsupervised learning techniques including clustering and dimensionality reduction.
5. To evaluate machine learning models using appropriate performance metrics.
6. To design, implement, and test Artificial Neural Networks using Python-based tools.

**Lab Outcomes:**

**Upon completion of this course, Learners will be able to:**

1. Use Python and key ML libraries for preprocessing, visualization, and model building.
2. Perform complete data preprocessing, including missing-value handling, outlier detection, splitting, and feature scaling.
3. Implement and evaluate supervised ML algorithms (regression, classification, decision trees, SVM, and KNN).
4. Apply and analyse unsupervised methods, including clustering and dimensionality reduction.
5. Apply ensemble techniques and compare them with individual models.
6. Design, train, and test Artificial Neural Networks with Python libraries.

**Suggested List of Experiments:** Students are required to complete at least 12 experiments.

Star (\*) marked experiments are compulsory.

| Sr. No. | Title of Experiments                                                                                                                                                                                                                                                                                                                  | LO  |
|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| 1*      | Learn various Libraries in Python used for Machine Learning such as: Scikit-Learn, TensorFlow, Keras, NumPy, Pandas, Matplotlib, Seaborn etc.                                                                                                                                                                                         | LO1 |
| 2*      | For a given set of training data examples stored in a .CSV file, demonstrate Data Preprocessing in Machine learning with the following steps a) Getting the dataset. b) Importing libraries. c) Importing datasets. d) Finding Missing Data. e) Finding Outliers f) Splitting dataset into training and test set. g) Feature scaling. | LO2 |
| 3*      | Build a linear regression model using python for a particular data set by a) Splitting Training data and Test data. b) Evaluate the model (intercept and slope). c) Visualize the training set and testing set d) Predict the test set result e) Compare actual output values with predicted values.                                  | LO3 |
| 4*      | Build a multiple linear regression model using python for a particular data set by a) Splitting Training data and Test data. b) Evaluate the model (intercept and slope). c) Visualize the training set and testing set d) predicting the test set result e) compare actual output values with predicted values.                      | LO3 |
| 5*      | Implement Logistic regression with sample dataset and evaluate it using various performance measure                                                                                                                                                                                                                                   | LO3 |
| 6*      | Implement the following classification algorithms with sample dataset and evaluate it using various performance measure<br>Decision tree<br>KNN (use k=1, 3, 5 etc.), SVM                                                                                                                                                             | LO3 |
| 7*      | Implement the following clustering algorithms with sample dataset and visualize the resultant clusters.<br>K-means (use k=2, 3, 5 etc.)<br>Hierarchical clustering algorithms (using all the linkage criteria)                                                                                                                        | LO4 |
| 8       | Implement the DBSCAN clustering algorithms with sample dataset and visualize the resultant clusters.                                                                                                                                                                                                                                  | LO4 |
| 9*      | Implement PCA to find the first n (eg. n=1, 2, ...10 etc.) principal components. Consider any suitable dataset (eg. Iris, Ionoshpre).                                                                                                                                                                                                 | LO4 |
| 10*     | Implement Random Forest Algorithm using a sample dataset                                                                                                                                                                                                                                                                              | LO5 |
| 11      | Implement Ensemble Learning using a sample dataset (Bagging/Boosting).                                                                                                                                                                                                                                                                | LO5 |
| 12*     | Build an Artificial Neural Network by implementing the Backpropagation algorithm and test the same using appropriate data sets.                                                                                                                                                                                                       | LO6 |

**Textbooks:**

1. Andreas C. Muller and Sarah Guido, Introduction to Machine Learning with Python, O'Reilly Publication
2. Francois Chollet, Deep Learning with Python (Second Edition), Manning Pubns Co.
3. Ian Goodfellow, Yoshua Bengio, Aaron Courville, Deep Learning, MIT Press, 2016

**Reference books:**

1. Christopher M Bishop, Neural Networks For Pattern Recognition, Oxford University Press

**Online Resources:**

- 1 NPTL Course : <https://nptel.ac.in/courses/106106247>
- 2 Machine Learning Course : <https://developers.google.com/machine-learning/crash-course> :
- 2 <https://www.fast.ai/>:
- 3 Deep Learning Course : <https://www.deeplearning.ai/>
- 4 Data sets for Machine Learning algorithms: <https://www.kaggle.com/learn> :
- 5 Machine Learning Course : <https://machinelearningmastery.com/>
- 6 Data Science Course: <https://towardsdatascience.com/>
- 7 SCIKIT Course: <https://scikit-learn.org/>
- 8 Tutorials & Courses: <https://www.tensorflow.org/>

**Term Work:**

- Term work should consist of at least 10 experiments.

The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. The assignments should be students' centric, and an attempt should be made to make assignments more meaningful, interesting and innovative. Term work will be assessed as Continuous Internal Assessment Practical (CIAP).

**Term work Marks (CIAP):**

- 25 Marks (Total Marks) = 20 Marks (Experiment) + 05 Marks (Attendance)
- The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.

| Course Code | Course Name             | Teaching Scheme (Hrs.) |           |          | Credits Assigned |           |          |       |
|-------------|-------------------------|------------------------|-----------|----------|------------------|-----------|----------|-------|
|             |                         | Theory                 | Practical | Tutorial | Theory           | Practical | Tutorial | Total |
| MDML5051    | Advanced Algorithms Lab | --                     | 02        | --       | --               | 01        | --       | 01    |

| Course Code | Course Name             | Examination Scheme |     |     |      |      |       |
|-------------|-------------------------|--------------------|-----|-----|------|------|-------|
|             |                         | Theory Marks       |     |     | CIAP | ESEP | Total |
|             |                         | Course Assessment  |     | ESE |      |      |       |
|             |                         | ISE                | MSE |     |      |      |       |
| MDML5051    | Advanced Algorithms Lab | --                 | --  | --  | 25   | --   | 25    |

**Pre- requisite:**

1. FEC104: C Programming
2. CSEC302 Data Structures & Algorithms

**Program Outcomes Addressed**

1. PO1: Engineering Knowledge
2. PO2: Problem Analysis
3. PO3: Design/Development of Solutions
4. PO4: Conduct Investigations of Complex Problems
5. PO11: Life-Long Learning

**Lab Objectives:**

1. Introduce fundamental algorithm-analysis techniques
2. Develop the ability to apply probabilistic and randomized approaches
3. Equip students with the knowledge of dynamic programming principles.
4. Impart understanding of graph algorithms and flow-network techniques.
5. Provide competency in applying algorithmic strategies
6. Build an understanding of computational complexity classes

**Lab Outcomes:**

**Upon completion of this course, Learners will be able to:**

1. Analyze various types of algorithms by applying different mathematical analysis techniques.
2. Understand and apply probabilistic analysis and randomized algorithms.
3. Develop dynamic programming algorithms for various real-time applications.
4. Apply appropriate graph-based algorithm for the various flow networks
5. Apply appropriate algorithms to solve computational and linear programming problems
6. Understand complexity classes through implementation and case studies.

**Suggested List of Experiments:** Students are required to complete at least 12 experiments.

| Sr. No. | Title of Experiments                                                                                                                                                                                                                                                                                                                                                                                         | LO  |
|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| 1       | A software development team is optimizing algorithms for a performance-critical application and needs to compare different implementation approaches. Students are required to implement both recursive and non-recursive (iterative) versions of algorithms (such as factorial, Fibonacci, or searching) and analyze their performance in terms of time, space, and efficiency.                             | LO1 |
| 2       | A software company is developing a system that performs frequent operations such as dynamic array insertions and stack operations, where occasional expensive operations may occur. Students are required to study and implement <b>amortized analysis</b> to evaluate the average cost per operation over a sequence of operations.                                                                         | LO1 |
| 3       | A software company handling large datasets needs an efficient sorting technique that performs well even with unpredictable input patterns. Students are required to implement a randomized algorithm using <b>Randomized Quicksort</b> , where the pivot is selected randomly to improve average performance and avoid worst-case scenarios.                                                                 | LO2 |
| 4       | A company conducting a recruitment drive wants to select the best candidates from a sequence of applicants interviewed one by one, where each candidate has a performance rating. Students are required to implement the <b>Hiring Problem</b> , selecting a candidate only if they are better than all previously interviewed candidates, and print the number of hires along with their ratings.           | LO2 |
| 5       | A logistics company managing multiple delivery routes needs to determine the shortest paths between all pairs of locations to optimize transportation time and cost. Students are required to implement an all-pairs shortest path algorithm using dynamic programming, specifically the <b>Floyd-Warshall algorithm</b> , to compute the minimum distances between every pair of nodes in a weighted graph. | LO3 |
| 6       | A logistics company needs to maximize profit while transporting goods with limited vehicle capacity, where each item can either be fully included or excluded. Students are required to implement the <b>0/1 Knapsack problem</b> using dynamic programming to determine the optimal selection of items.                                                                                                     | LO3 |
| 7       | A company performing large-scale data processing needs to multiply multiple matrices efficiently, where the order of multiplication significantly affects computation time. Students are required to implement the <b>Matrix Chain Multiplication</b> using dynamic programming to determine the optimal parenthesization that minimizes the number of scalar multiplications.                               | LO3 |
| 8       | A transportation network system needs to determine the shortest paths from a source location to all other locations, even when some routes have negative costs (such as discounts or rebates). Students are required to implement the <b>Bellman-Ford algorithm</b> using dynamic programming to compute shortest distances and detect negative weight cycles.                                               | LO3 |
| 9       | A logistics or network service provider needs to determine the maximum possible flow of resources (such as data, traffic, or goods) from a source to a destination through a network with capacity constraints on each link. Students are required to implement the <b>Ford-Fulkerson algorithm</b> to compute the maximum flow in a given network.                                                          | LO4 |
| 10      | A network service provider needs to determine the maximum data flow from a source to a destination while efficiently handling capacity constraints and ensuring optimal routing. Students are required to implement the <b>Edmonds-Karp algorithm</b> , an optimized version of the Ford-Fulkerson method that uses BFS to                                                                                   | LO4 |

|    |                                                                                                                                                                                                                                                                                                                                                           |     |
|----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
|    | find shortest augmenting paths.                                                                                                                                                                                                                                                                                                                           |     |
| 11 | A large-scale network system, such as data centers or transportation grids, needs to efficiently manage and maximize the flow of resources between source and destination under capacity constraints. Students are required to implement the <b>Push-Relabel algorithm</b> , which uses preflows and height functions to optimize flow distribution.      | LO4 |
| 12 | A geographic mapping company needs to determine the outer boundary of a set of location points to efficiently represent regions such as land plots or coverage areas. Students are required to implement the <b>Graham Scan algorithm</b> to compute the convex hull of given 2D points in counterclockwise order without duplicating the starting point. | LO5 |
| 13 | A manufacturing company aims to maximize its profit by optimally allocating limited resources such as labor, materials, and time across different products. Students are required to implement the <b>Simplex algorithm</b> to solve a linear programming problem and determine the optimal solution.                                                     | LO5 |
| 14 | A data analytics company handling large datasets needs to improve sorting performance by utilizing multi-core processors efficiently. Students are required to design and implement <b>Parallel Merge Sort using multithreading</b> , where the array is divided into subarrays and sorted concurrently in separate threads before merging.               | LO6 |
| 15 | Design the 2-approximation vertex-cover algorithm for an undirected graph $G(V, E)$ .                                                                                                                                                                                                                                                                     | LO6 |

### Textbooks:

1. T. H. Cormen, C. E. Leiserson, R. L. Rivest, and C. Stein, *Introduction to Algorithms*, 4th ed. Cambridge, MA, USA: MIT Press, 2022. Algorithms: Design and Analysis, Harsh Bhasin, OXFORD.
2. H. Bhasin, *Algorithms: Design and Analysis*. New Delhi, India: Oxford University Press, 2016. C and Data structures, Deshpande, Kakde, Dreamtech Press.
3. E. Horowitz, S. Sahni, and S. Rajasekaran, *Fundamentals of Computer Algorithms*. Hyderabad, India: Universities Press, 2008.
4. A. A. Deshpande and O. G. Kakde, *C and Data Structures*. New Delhi, India: Dreamtech Press, 2004.

### Reference books:

1. M. T. Goodrich, R. Tamassia, and D. M. Mount, *Data Structures and Algorithms in C++*, 2nd ed. Hoboken, NJ, USA: Wiley, 2011.
2. R. Thareja, *Data Structures Using C*, 3rd ed. New Delhi, India: Oxford University Press, 2023.
3. M. A. Weiss, *Data Structures and Algorithm Analysis in C*, 2nd ed. Upper Saddle River, NJ, USA: Pearson Education, 2002.
4. R. K. Arora, *Optimization: Algorithms and Applications*. Boca Raton, FL, USA: Chapman & Hall/CRC Press, 2015.

**Online Resources:**

1. NPTEL Course: <https://nptel.ac.in/courses/106/106/106106131/>
2. Swayam Course : [https://swayam.gov.in/nd1\\_noc19\\_cs47/preview](https://swayam.gov.in/nd1_noc19_cs47/preview)
3. Coursera Course : <https://www.coursera.org/specializations/algorithms>
4. Mooc Course: <https://www.mooc-list.com/tags/algorithms>

**Software Tools:**

1. Dev C++
2. Google Collaboratory notebook

**Term Work:**

- Term work should consist of at least 12 experiments. Term work will be assessed as Continuous Internal Assessment Practical (CIAP).

**Term work Marks (CIAP):**

- 25 Marks (Total Marks) = 20 Marks (Experiments) + 05 Marks (Attendance). The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.

| Course Code | Course Name  | Credits Assigned |           |          |       |
|-------------|--------------|------------------|-----------|----------|-------|
|             |              | Theory           | Practical | Tutorial | Total |
| CSEM501     | Mini Project | --               | 1         | --       | 1     |

| Course Code | Course Name  | Examination Scheme |     |     |      |      |       |
|-------------|--------------|--------------------|-----|-----|------|------|-------|
|             |              | Theory Marks       |     |     | CIAP | ESEP | Total |
|             |              | Course Assessment  |     | ESE |      |      |       |
|             |              | ISE                | MSE |     |      |      |       |
| CSEM501     | Mini Project | --                 | --  | --  | 25   | 25   | 50    |

**Program Outcomes addressed:**

1. PO1: Engineering knowledge.
2. PO2: Problem Analysis.
3. PO3: Design/Development of Solutions.
4. PO4: Conduct Investigations of Complex Problems.
5. PO5: Engineering Tool Usage.
6. PO6: The Engineer and The World.
7. PO7: Ethics.
8. PO8: Individual and Collaborative Team work.
9. PO9: Communication.
10. PO10: Project Management and Finance.
11. PO11: Life-Long Learning.

**Objectives:**

1. To identify user or societal needs and formulate clear problem statements.
2. To work collaboratively for effective problem-solving.
3. To apply engineering fundamentals to develop feasible solutions.
4. To promote self-learning and research-oriented thinking.

**Outcomes:** Upon completion of this course, learners will be able to:

1. Identify and define real-world or research problems through requirement gathering and stakeholder interaction.
2. Develop project objectives, scope, and feasibility using software engineering and SDLC principles.
3. Analyze requirements and develop system designs using standard modelling techniques.
4. Implement solutions using appropriate technologies, engineering practices, and version control.
5. Test and validate the system through structured test cases, datasets, and simulations.
6. Compose technical documentation, present project outcomes, and demonstrate teamwork, ethics, and self-learning.

### **Guidelines for Mini Project**

1. Students shall form groups of 3 to 4 members; groups with fewer than three or more than four students are not permitted.
2. Students should conduct surveys to identify needs and develop problem statements in consultation with faculty.
3. Each group shall submit an implementation plan using a Gantt Chart, PERT, or CPM chart, covering weekly activities and milestones.
4. Every group must maintain a logbook to record weekly progress, tasks completed, challenges faced, and supervisor's comments and signatures.
5. Faculty supervisors may provide necessary guidance; however, emphasis shall be on self-learning, independent thinking, and initiative.
6. Students should understand the problem thoroughly, propose multiple solution approaches, and select the most appropriate solution in consultation with the supervisor.
7. Students shall develop the selected solution into a working model using domain-specific tools, technologies, or components and demonstrate the same.
8. The solution must be validated using proper justification through test cases, benchmark data, experimentation, or simulations, and the final report must be compiled as per the guidelines for the project report.
9. To promote innovation, societal relevance, self-learning, and entrepreneurial mindset, it is recommended that a single project be carried out across two consecutive semesters (Mini Project II in Sem V & VI).
10. If a group completes the project with required quality in the odd semester, they may, based on supervisor recommendation, either extend the project with improvements or begin a new project in the even semester; this may be permitted on a case-by-case basis.
11. Students must follow ethical practices, maintain academic integrity, avoid plagiarism, and appropriately acknowledge all references and sources used.
12. Students are encouraged to use standard engineering tools such as version control systems (e.g., Git), project management tools, and proper documentation tools during project execution.
13. Evaluation will consider problem identification, planning, implementation quality, testing and validation, documentation, presentation, teamwork, and overall contribution.
14. Students should be encouraged to explore opportunities for innovation, entrepreneurship, and potential intellectual property creation such as patent, copyright, or research publication.
15. Students must follow lab safety norms and responsibly use equipment, hardware, and computational resources during the execution of the project.

### **Guidelines for the Project Report:**

1. Report should not exceed 30 pages. Simply staple it to discourage use of plastic.
2. Report must contain Gantt chart, architectural diagram, Data Flow Diagrams, applicable UML diagrams, screenshot of outputs (Include only required information pages).
3. The recommended report writing format is in LaTeX.

### **Guidelines for Assessment of Mini Project: Term Work**

- A Review/Progress Monitoring Committee shall be constituted by the Head of Department. Mini Project progress shall be evaluated continuously, with a minimum of two reviews per semester.
- Continuous assessment shall also emphasize individual performance, including each student's contribution, understanding of the project, and responses during review interactions.
- The distribution of Term Work marks for both semesters shall be as follows:
  1. Marks by Guide/Supervisor based on Logbook: 10
  2. Marks by Review Committee: 10
  3. Quality of Project Report: 05

The Review/Progress Monitoring Committee may consider the following points, depending on whether the project spans one year or one semester.

#### **One-year project:**

- In the first semester the entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on the presentation given by the students' group.
  - **First Review:** Finalization of the problem statement
  - **Second Review:** Finalization of the proposed solution
- In the second semester the expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.
  - **First Review:** Readiness for building the working prototype
  - **Second Review:** Poster presentation and demonstration of the working model in the last month of the semester

#### **Half-year project:**

- In this case in one semester students' group shall complete project in all aspects including,
  - Identification of need/problem
  - Proposed final solution
  - Procurement of components/systems
  - Building prototype and testing
- Two reviews will be conducted for continuous assessment,
  - **First Review:** Finalization of problem and proposed solution
  - **Second Review:** Implementation and testing of the solution

#### **Assessment criteria for the Mini Project.**

**Mini Project** shall be assessed based on the following criteria;

1. Quality of Survey and Need Identification
  2. Clarity and Completeness of Problem Definition
  3. Innovativeness and Creativity in Proposed Solutions
  4. Feasibility of Solution and Justification of Selected Approach
  5. Cost Effectiveness and Societal/Environmental Impact
  6. Quality of System Design and Use of Engineering Norms
  7. Implementation Quality and Functioning of Prototype as per Requirements
  8. Effective Use of Technical Skill Sets and Tools
  9. Teamwork, Leadership, and Individual Contribution
  10. Clarity in Documentation, Presentation, and Communication
- In **one year, project**, first semester evaluation may be based on the first six criteria's and the remaining may be used for second semester evaluation of performance of students in mini project.
  - In the case of **half year project** all criteria's in generic may be considered for evaluation of performance of students in mini project.

#### **Guidelines for Assessment of Mini Project Practical/Oral Examination:**

- The report should be prepared as per the guidelines issued by the University of Mumbai.
- Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organization's having experience of more than five years approved by the head of Institution.
- Students shall be motivated to publish a paper based on the work in Conferences/students

competitions.

**Mini Project** shall be assessed based on the following rubrics:

1. Quality of problem identification & clarity
2. Innovation & creativity in solution
3. Feasibility, cost effectiveness & societal impact
4. Functionality and correctness of the working model
5. Effective use of engineering tools and skill sets
6. Adherence to engineering standards and norms
7. Individual contribution and teamwork
8. Written and oral communication skills

| Course Code | Course Name                    | Teaching Scheme (Hrs.) |           |          | Credits Assigned |           |          |       |
|-------------|--------------------------------|------------------------|-----------|----------|------------------|-----------|----------|-------|
|             |                                | Theory                 | Practical | Tutorial | Theory           | Practical | Tutorial | Total |
| CSEC601     | IoT Architecture and Protocols | 03                     | --        | --       | 03               | --        | --       | 03    |

| Course Code | Course Name                    | Examination Scheme |     |                   |      |      |       |
|-------------|--------------------------------|--------------------|-----|-------------------|------|------|-------|
|             |                                | Theory Marks       |     |                   | CIAP | ESEP | Total |
|             |                                | Course Assessment  |     | ESE <sup>\$</sup> |      |      |       |
|             |                                | ISE                | MSE |                   |      |      |       |
| CSEC601     | IoT Architecture and Protocols | 20                 | 20  | 60                | --   | --   | 100   |

**Pre-requisite:**

1. CSEL304: Python programming
2. FEC104 : C programming language
3. CSED403: Computer Networks

**Program Outcomes Addressed:**

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO3: Design and development
4. PO11: Lifelong Learning

**Course Objectives:**

1. To understand IoT applications.
2. To familiarize with IoT Architectures.
3. To learn about IoT devices and event driven analysis
4. To apply and analyze IIoT.
5. To acquaint safety and security testing of IoT systems.
6. To test Networking protocol in IoT systems

**Course Outcomes:** Learners will be able to:

1. Comprehend the essentials of IoT and its applications
2. Understand the concepts of IoT Architecture Reference model and IoT reference architecture
3. Analyze various IoT Application layer Protocols.
4. Apply IP based protocols and Authentication Protocols for IoT
5. Design IoT-based systems for real-world problems.
6. Develop IoT infrastructure for popular applications

| Module No. | Unit No. | Topics                                                                                                                                                     | Hrs. | CO  |
|------------|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-----|
| 1.0        |          | <b>The IoT Landscape</b>                                                                                                                                   | 06   |     |
|            | 1.1      | <b>Introduction to IoT:</b> Definition of IoT, Applications, Architectures, Wireless Networks, Devices, Security and Privacy, Event Driven Systems.        |      | CO1 |
|            | 1.2      | <b>IoT System Architectures:</b> Introduction, Protocols Concepts, IoT oriented Protocols, Databases, Time Bases, Security.                                |      |     |
|            |          | <b>Self-Learning:</b> IoT application for real life with data privacy.                                                                                     |      |     |
| 2.0        |          | <b>IoT-An Architectural Overview</b>                                                                                                                       | 05   |     |
|            | 2.1      | <b>IoT-An Architectural Overview:</b> Building architecture, Main design principles and needed capabilities,                                               |      | CO2 |
|            | 2.2      | An IoT architecture outline, standards considerations                                                                                                      |      |     |
|            |          | <b>Self-Learning:</b> Architectural differences in Microprocessor, Microcontroller and IoT systems.                                                        |      |     |
| 3.0        |          | <b>Architecture-State of the Art</b>                                                                                                                       | 08   |     |
|            | 3.1      | <b>IoT Architecture-State of the Art:</b> Introduction, State of the art, Reference Model and architecture, .                                              |      | CO3 |
|            | 3.2      | <b>IoT reference Model:</b> IoT Reference Architecture Introduction, Functional View, Information View,                                                    |      |     |
|            | 3.3      | <b>Deployment:</b> Deployment and Operational View, Other Relevant architectural Views.                                                                    |      |     |
|            |          | <b>Self-learning:</b> Serverless IoT Architecture (FaaS-based IoT systems), Microservices vs Monolithic architectures in IoT                               |      |     |
| 4.0        |          | <b>Industrial Internet of Things &amp; Security and Safety</b>                                                                                             | 06   |     |
|            | 4.1      | Industrial Internet of Things & Security and Safety: Industrial Internet of Things & Security and Safety. Basic Technologies, Applications and Challenges. |      | CO4 |
|            | 4.2      | <b>Security and Safety:</b> Introduction, Systems Security, Network Security, Generic Application Security, Application Process Security and Safety        |      |     |
|            |          | <b>Self-Learning:</b> IIoT case study.                                                                                                                     |      |     |
| 5.0        |          | <b>IoT Data Link Layer</b>                                                                                                                                 | 07   |     |
|            | 5.1      | <b>IoT Data Link Layer:</b> PHY/MAC Layer (3GPP MTC, IEEE 802.11, IEEE 802.15)                                                                             |      | CO5 |
|            | 5.2      | <b>Wireless HART :</b> Wave, Bluetooth Low Energy, Zigbee Smart Energy, DASH7.                                                                             |      |     |
|            |          | <b>Self-learning:</b> Link Layers for smart systems.                                                                                                       |      |     |
| 6.0        |          | <b>Network Layer Protocols &amp; IOT Transport &amp; Session Layer Protocols</b>                                                                           | 07   |     |

|  |     |                                                                                                                                    |           |            |
|--|-----|------------------------------------------------------------------------------------------------------------------------------------|-----------|------------|
|  |     |                                                                                                                                    |           |            |
|  | 6.1 | <b>Network Layer Protocols:</b> Network Layer-IPv4, IPv6, 6LoWPAN, 6TiSCH, ND, DHCP, ICMP IOT Transport & Session Layer Protocols: |           | <b>CO6</b> |
|  | 6.2 | <b>Transport Layer:</b> TCP, MPTCP, UDP, DCCP, SCTP, (TLS, DTLS) – Session Layer-HTTP, CoAP                                        |           |            |
|  |     | <b>Self-learning:</b> Various Protocols in practical appliances at any premises.                                                   |           |            |
|  |     | <b>Total</b>                                                                                                                       | <b>39</b> |            |

#### Textbooks:

1. D. Serpanos and M. Wolf, *Internet-of-Things (IoT) Systems Architectures, Algorithms, Methodologies*. Cham: Springer, 2018, ISBN: 978-3-319-69714-7.
2. D. Minoli, *Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications*. Hoboken, NJ, USA: Wiley, 2016, ISBN: 978-1-118-47347-4.
3. J. Holler, V. Tsiatsis, C. Mulligan, S. Avesand, S. Karnouskos, and D. Boyle, *From Machine- to-Machine to the Internet of Things: Introduction to a New Age of Intelligence*. Burlington, MA, USA: Academic Press, Second edition 2018
4. D. Hanes, G. Salgueiro, P. Grossetete, R. Barton, and J. Henry, *IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things*. Cisco Press.

#### Reference Books:

1. B. Scholz-Reiter and F. Michahelles, *Architecting the Internet of Things*. Springer, 2016, ISBN: 978-3-642-19156-5.
2. N. Ida, *Sensors, Actuators and Their Interfaces*. SciTech Publishing, 2014.

#### Online Resources

1. <https://owasp.org/www-project-internet-of-things/>
2. <https://wokwi.com>
3. <https://www.tinkercad.com/circuits>

#### NPTEL Course

4. <https://nptel.ac.in/courses/106/105/106105166/>
5. [https://onlinecourses.nptel.ac.in/noc21\\_ee85/preview](https://onlinecourses.nptel.ac.in/noc21_ee85/preview)

#### Course Assessment:

##### ISE:

- To be conducted in any of these forms - Assignment/ Quiz/ Presentation/ Class Test/ Case study etc. of 20 marks.
- ISE 20 marks = 05 marks for attendance + 15 marks for activities.

**MSE:**

- To be conducted as written examination for 20 marks (on 40% - 50% syllabus)

**End Semester Examination:**

**\$ ESE of duration 03 hours are 80 marks and scaled to 60.**

1. Question paper will comprise 03 questions.
2. Question1 (20 marks): - Solve any 04 out of 06. All questions carry 05 marks each.
3. Question 2 (40 marks): - Solve any 04 out of 06. All questions carry 10 marks each.
4. Question 3 (20 marks): - Solve any 04 out of 06. All questions carry 05 marks each.
5. All COs should be mapped as per the weightage in the syllabus.

| Course Code | Course Name                   | Teaching Scheme (Hrs.) |           |          | Credits Assigned |           |          |       |
|-------------|-------------------------------|------------------------|-----------|----------|------------------|-----------|----------|-------|
|             |                               | Theory                 | Practical | Tutorial | Theory           | Practical | Tutorial | Total |
| CSEC602     | Advance Blockchain Technology | 02                     | -         | -        | 02               | -         | -        | 02    |

| Course Code | Course Name                   | Examination Scheme |     |       |      |      |       |
|-------------|-------------------------------|--------------------|-----|-------|------|------|-------|
|             |                               | Theory Marks       |     |       | CIAP | ESEP | Total |
|             |                               | Course Assessment  |     | ESE\$ |      |      |       |
|             |                               | ISE                | MSE |       |      |      |       |
| CSEC602     | Advance Blockchain Technology | 15                 | 15  | 45    | --   | --   | 75    |

**Pre-requisite:**

1. CSEC503 - Introduction to Blockchain Technology

**Program Outcomes addressed:**

1. PO1: Engineering Knowledge
2. PO2: Problem Analysis
3. PO6: Engineer and the world
4. PO7: Ethics
5. PO11: Life-Long Learning

**Course Objectives:**

1. To introduce the concepts and approaches of decentralization, blockchain ecosystems, and decentralized organizations.
2. To introduce enterprise blockchain concepts, architectures, industry impact, and BaaS models.
3. To Understand blockchain interoperability, challenges, and cross-chain protocols.
4. To Analyze key challenges in blockchain systems.
5. To Identify blockchain vulnerabilities, security threats, and mitigation measures.
6. To introduce blockchain-IoT integration and government applications.

**Course Outcomes: Learners will be able to**

1. Explain decentralization approaches, blockchain ecosystems, and decentralized organizational structures.
2. Analyze enterprise blockchain features, adoption benefits, architectural model, industry impact, and cloud-based BaaS deployments.
3. Evaluate blockchain interoperability challenges, technologies, and protocols.
4. Analyze scalability, privacy mechanisms, and key blockchain challenges.
5. Distinguish vulnerabilities, security risks, and mitigation techniques in blockchain systems.
6. Analyze blockchain-IoT models and government use cases.

| Module No. | Unit No. | Topics                                                                                                                                                                                                                                                                                | Hrs. | CO  |
|------------|----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-----|
| 1.0        |          | <b>Decentralization using Blockchain</b>                                                                                                                                                                                                                                              | 04   |     |
|            | 1.1      | Introduction, Methods of Decentralization, Routes to decentralization, Blockchain and full Ecosystem Decentralization, Decentralized Organizations.                                                                                                                                   |      | CO1 |
|            |          | <b>Self-Learning:</b> Decentralized Identity, Self-Sovereign Identity                                                                                                                                                                                                                 |      |     |
| 2.0        |          | <b>Blockchain for Enterprises</b>                                                                                                                                                                                                                                                     | 04   |     |
|            | 2.1      | Why blockchain is important for Enterprises, Key features, Benefits of implementing Blockchain in enterprises, Potential impact of Blockchain across various industries, Enterprise Blockchain Architecture, Blockchain in the cloud-BaaS                                             |      | CO2 |
|            |          | <b>Self-Learning:</b> R3 Corda, Quorum, Case studies of successful enterprise blockchain implementations                                                                                                                                                                              |      |     |
| 3.0        |          | <b>Blockchain Interoperability</b>                                                                                                                                                                                                                                                    | 05   |     |
|            | 3.1      | <b>Interoperability:</b> Siloed Blockchain Networks, Blockchain Ecosystems, Network Limitations, Interchain Communication, Need for interoperability, Understanding Blockchain interoperability, what can interoperable blockchains achieve? Challenges in Achieving interoperability |      | CO3 |
|            | 3.2      | <b>Interoperability Technologies:</b> Atomics Swaps, Bridges and its types, Relays, Single Custodian, Multi signature Federation, Hash locking, Interoperability protocols: Polkadot                                                                                                  |      |     |
|            |          | <b>Self-Learning:</b> Interoperability protocols: XCM, Cosmos IBC, LayerZero ULN, Chainlink CCIP, Use Cases for Blockchain Interoperability.                                                                                                                                          |      |     |
| 4.0        |          | <b>Scalability and Challenges in Blockchain</b>                                                                                                                                                                                                                                       | 05   |     |
|            | 4.1      | <b>Scalability:</b> Blockchain Planes, Methods for improving scalability.                                                                                                                                                                                                             |      | CO4 |
|            | 4.2      | <b>Privacy:</b> Anonymity, Confidentiality, Techniques to achieve Privacy.                                                                                                                                                                                                            |      |     |
|            | 4.3      | <b>Other Challenges:</b> Interoperability, Lack of standardization, post-Quantum resistance, Compliance and Regulation.                                                                                                                                                               |      |     |
|            |          | <b>Self-Learning:</b> Case Study Analysis: Pick a blockchain network and analyze how it addresses scalability, privacy, and interoperability.                                                                                                                                         |      |     |
| 5.0        |          | <b>Blockchain Vulnerabilities and Securities</b>                                                                                                                                                                                                                                      | 05   |     |
|            | 5.1      | <b>Vulnerabilities:</b> Client Vulnerabilities, Consensus mechanism Vulnerabilities, Mining pool Vulnerabilities, Network Vulnerabilities, Smart contract vulnerabilities.                                                                                                            |      | CO5 |
|            | 5.2      | <b>Securities:</b> Blockchain layers and attacks, Attacks on layer 2 blockchains, Security analysis tools and mechanisms, Regulations and Compliance                                                                                                                                  |      |     |
|            |          | <b>Self-Learning:</b> Investigate a real hack on blockchain explorers: Poly Network hack, Ronin network exploit, Wormhole bridge hack                                                                                                                                                 |      |     |

| 6.0 |     | Blockchain-Outside of Cryptocurrencies                                                                        | 03 |     |
|-----|-----|---------------------------------------------------------------------------------------------------------------|----|-----|
|     | 6.1 | <b>IoT:</b> Blockchain based IoT model, Benefits of IoT and Blockchain Convergence.                           |    | CO6 |
|     | 6.2 | <b>Government:</b> Border Control, Citizen Identification cards.                                              |    |     |
|     |     | <b>Self-Learning:</b> Applications of Blockchain in Health, Finance, Media and Real Estate, Blockchain and AI |    |     |
|     |     | <b>Total</b>                                                                                                  | 26 |     |

#### Textbooks:

1. Imran Bashir, *Advanced Blockchain Development: Build Highly Secure, Decentralized Applications and Conduct Secure Transactions*, 1st ed. Packt Publishing, 2021.
2. Imran Bashir, *Mastering Blockchain: Inner Workings of Blockchain, from Cryptography and Decentralized Identities, to DeFi, NFTs and Web3*, 2nd ed. Packt Publishing, 2021.
3. N. Prusty, *Blockchain for Enterprise: Build Scalable Blockchain Applications with Privacy, Interoperability, and Permissioned Features*, 1st ed. Packt Publishing, 2021.
4. L. Nadkar and P. Sarang, *Blockchain Without Barriers: An Authentic Guide to Blockchain Interoperability*, 1st ed. Packt Publishing, 2022.

#### Reference books:

1. J. Holbrook, *Architecting Enterprise Blockchain Solutions*, 1st ed. Apress, 2022.
2. P. Jones, *Enterprise Blockchain: Applications and Use Cases*, 1st ed. Apress, 2021. P. Jones, *Enterprise Blockchain: Applications and Use Cases*, 1st ed. Apress, 2021.
3. R. Sharma, K. Mehta, V. Vyas, and V. K. Shukla, *Decentralized Finance and Blockchain: A Game Changing Duo*, 1st ed. Springer, 2022.
4. I. Bashir, *Mastering Blockchain: A Deep Dive into Distributed Ledgers, Consensus Protocols, Smart Contracts, DApps, Cryptocurrencies, Ethereum, and More*, 3rd ed. Packt Publishing, 2023.
5. Y. Cai, Q. Li, and X. Liang, *Advanced Blockchain Technology: Frameworks and Enterprise-Level Practices*, 1st ed. Springer, 2022.

#### Online References:

1. Coursera: <https://www.coursera.org/specializations/from-blocks-to-build-blockchain-dev-essentials#courses>
2. NPTEL Course: [https://onlinecourses.nptel.ac.in/noc26\\_cs34/](https://onlinecourses.nptel.ac.in/noc26_cs34/)
3. NPTEL Course: [https://onlinecourses.nptel.ac.in/noc20\\_cs01/](https://onlinecourses.nptel.ac.in/noc20_cs01/)
4. NPTEL Course: [https://onlinecourses-archive.nptel.ac.in/noc18\\_cs47](https://onlinecourses-archive.nptel.ac.in/noc18_cs47)

#### Course Assessment:

##### ISE:

- To be conducted in any of these forms - Assignment/ Quiz/ Presentation/ Class Test/ Case study etc. of 15 marks.
- ISE 15 marks=05 marks for attendance + 10 marks for activities.

##### MSE:

- To be conducted as written examination for 15 marks (on 40% -50% syllabus).

**End Semester Examination:**

**\$ ESE of duration 02 hours are of 60 marks and scaled to 45.**

1. Question paper will comprise of 03 questions.
2. Question1(15 marks): - Solve any 03 out of 04. All questions carry 05 marks each.
3. Question 2 (30 marks): - Solve any 03 out of 05. All questions carry 10 marks each.
4. Question 3 (15 marks): - Solve any 03 out of 04. All questions carry 05 marks each.
5. All COs should be mapped as per the weightage in the syllabus.

Draft Copy

| Course Code | Course Name                           | Teaching Scheme (Hrs.) |           |          | Credits Assigned |           |          |       |
|-------------|---------------------------------------|------------------------|-----------|----------|------------------|-----------|----------|-------|
|             |                                       | Theory                 | Practical | Tutorial | Theory           | Practical | Tutorial | Total |
| CSEC603     | Digital Forensics and Ethical Hacking | 03                     | --        | --       | 03               | --        | --       | 03    |

| Course Code | Course Name                           | Examination Scheme |     |                  |      |      |       |
|-------------|---------------------------------------|--------------------|-----|------------------|------|------|-------|
|             |                                       | Theory Marks       |     |                  | CIAP | ESEP | Total |
|             |                                       | Course Assessment  |     | ESE <sup>s</sup> |      |      |       |
|             |                                       | ISE                | MSE |                  |      |      |       |
| CSEC603     | Digital Forensics and Ethical Hacking | 20                 | 20  | 60               | --   | --   | 100   |

**Prerequisite :**

1. CSEC403: Computer Networks,
2. CSEC501: Cryptography and Network security

**Program Outcomes addressed:**

1. PO1: Engineering knowledge.
2. PO2: Problem analysis.
3. PO3: Design/ Development of Solution
4. PO4: Conduct Investigations of Complex Problems
5. PO5 : Modern Tool Usage
6. PO7: Ethics
7. PO11: Life-Long Learning

**Course Objectives:**

1. To introduce the fundamentals of Digital Forensics including digital evidence, forensic processes, and incident response methodology.
2. To develop an understanding of forensic duplication and data acquisition techniques using open-source and proprietary tools across Windows and Linux environments.
3. To enable students to conduct forensic investigation and analysis, including artifact analysis, log investigation, data carving, and live forensics.
4. To explain ethical hacking concepts, phases, footprinting, scanning and legal compliances relevant to cybersecurity and investigations.
5. To equip learners with reconnaissance, scanning and vulnerability assessment techniques using industry tools like Nmap, Nessus, OpenVAS, Shodan, Maltego etc.
6. To provide knowledge of system and network hacking techniques, malware behavior, evasion techniques, and incident response fundamentals.

**Course Outcomes: Learner will be able to**

1. Explain the fundamental concepts of digital forensics and incident response including digital evidence, forensic lifecycle, and initial response procedures.
2. Perform forensic duplication and data acquisition of Windows and Linux systems using suitable tools for both static and live forensics.
3. Analyze and investigate digital evidence such as registry files, log files, carved data, and acquired system images on Windows and Linux platforms.
4. Demonstrate understanding of ethical hacking concepts, hacker classifications, hacking phases, footprinting, scanning, enumeration, and legal frameworks (IT Act 2000, DPDP 2023, PCI-DSS/GDPR).
5. Apply reconnaissance and vulnerability assessment techniques using OSINT tools, scanning tools, and vulnerability scanners to analyze security exposure.
6. Evaluate and demonstrate system and network hacking techniques, including password cracking, privilege escalation, malware analysis basics, sniffing, spoofing, MITM, and DoS/DDoS attacks.

| Module No. | Unit No.   | Topics                                                                                                                                                                                                                                                     | Hrs.      | CO         |
|------------|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|------------|
| <b>1.0</b> |            | <b>Introduction to Digital Forensics:</b>                                                                                                                                                                                                                  | <b>07</b> |            |
|            | <b>1.1</b> | Computer Networks, cryptography and system security, Introduction to Digital Forensics and Digital Evidence, The Need for Digital Forensics, Types of Digital Forensics, Digital Forensics Life Cycle.                                                     |           | <b>CO1</b> |
|            | <b>1.2</b> | <b>Incident and Initial Response:</b> Introduction to Computer Security Incident, Goals of Incident response, Incident Response Methodology, Initial Response, Formulating Response Strategy.                                                              |           |            |
|            |            | <b>Self-Learning:</b> New Challenges of Digital Forensic Investigations                                                                                                                                                                                    |           |            |
| <b>2.0</b> |            | <b>Digital Evidence, Forensic Duplication and Acquisition:</b>                                                                                                                                                                                             | <b>06</b> |            |
|            | <b>2.1</b> | <b>Forensic Duplication:</b> Introduction to Forensic Duplication, Types of Forensic Duplicates, Introduction to Forensic Duplication Tools.                                                                                                               |           | <b>CO2</b> |
|            | <b>2.2</b> | <b>Data Acquisition:</b> Introduction to Static and Live/Volatile Data, Static Data Acquisition from Windows (FTK Imager), Static Data Acquisition from Linux (dd/dcfldd), Live Data Acquisition from Windows (FTK Imager). Network Forensics (wireshark). |           |            |
|            |            | <b>Self-Learning:</b> Open and Proprietary Tools for Digital Forensics, Network Forensic Tools                                                                                                                                                             |           |            |



**SIES Graduate School of Technology**  
**Department of Computer Science and Engineering**  
**(Internet of Things and Cyber Security including Blockchain Technology)**  
**Bachelor of Engineering**

|            |            |                                                                                                                                                                               |           |            |
|------------|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|------------|
| <b>3.0</b> |            | <b>Forensic Investigation and Analysis:</b>                                                                                                                                   | <b>06</b> |            |
|            | <b>3.1</b> | Investigating Registry Files, Investigating Log Files, Data Carving (Bulk Extractor).                                                                                         |           | <b>CO3</b> |
|            | <b>3.2</b> | <b>Introduction to Forensic Analysis</b> , Live Forensic Analysis, Forensic Analysis of acquired data in Linux, Forensic Analysis of acquired data in Windows.                |           |            |
|            |            | <b>Self-learning:</b> Open and Proprietary Tools for Forensics Investigation                                                                                                  |           |            |
| <b>4.0</b> |            | <b>Introduction to Ethical Hacking and footprinting</b>                                                                                                                       | <b>06</b> |            |
|            | <b>4.1</b> | <b>Introduction to Ethical Hacking:</b> Introduction to Ethical Hacking. Hacker Classifications: The Hats. Phases of Hacking.                                                 |           | <b>CO4</b> |
|            | <b>4.2</b> | <b>Introduction to footprinting</b> , footprinting tools. Scanning methodology and tools. Enumeration techniques and enumeration tools.                                       |           |            |
|            | <b>4.3</b> | Legal Laws/Compliance and its Amendments: IT Act 2000 , IT (Amendment) Act 2008, DPDP 2023 , PCI DSS/GDPR awareness.                                                          |           |            |
|            |            | <b>Self-Learning:</b> Cybersecurity frameworks                                                                                                                                |           |            |
| <b>5.0</b> |            | <b>Reconnaissance and Scanning Technique</b>                                                                                                                                  | <b>07</b> |            |
|            | <b>5.1</b> | <b>Introduction to Techniques:</b> Footprinting and Reconnaissance Techniques (Active/Passive), OSINT Tools: Maltego, Recon-ng, Shodan, Scanning Networks using Nmap, Netcat. |           | <b>CO5</b> |
|            | <b>5.2</b> | <b>Different Assessment tools:</b> Enumeration of Services, Banner Grabbing, Vulnerability Assessment Tools (Nessus, OpenVAS).                                                |           |            |
|            |            | <b>Self learning :</b> Google Hacking (GHDB) and Doxing                                                                                                                       |           |            |
| <b>6.0</b> |            | <b>System and Network Hacking</b>                                                                                                                                             | <b>07</b> |            |
|            | <b>6.1</b> | <b>Hacking Concepts:</b> System Hacking Concepts and Phases, Password Cracking and Privilege Escalation.                                                                      |           | <b>CO6</b> |
|            | <b>6.2</b> | Network Hacking: Malware Types, Evasion Techniques, and Reverse Engineering Basics, Network Sniffing, Spoofing, and MITM Attacks, Denial of Service (DoS, DDoS) Attacks.      |           |            |
|            |            | <b>Self-learning:</b> Incident response tabletop, Threat intelligence basics                                                                                                  |           |            |
|            |            | <b>Total</b>                                                                                                                                                                  | <b>39</b> |            |

**Textbooks:**

1. N. Jain and D. R. Kalbande, Digital Forensics. New Delhi, India: Wiley, 2016.
2. N. A. Hassan, Digital Forensics Basics: A Practical Guide Using Windows OS. APress, 2019.
3. EC-Council, Ethical Hacking and Countermeasures: Attack Phases. Boston, MA: Cengage Learning., 2021.
4. William Stallings, Computer Security: Principles and Practice, 5th ed. Harlow, U.K.: Pearson Education, 2024.
5. Michael Gregg, Build Your Own Security Lab. New Delhi, India: Wiley India, 2017.

**Reference books:**

1. Kevin Beaver, Hacking For Dummies, 6th ed. Hoboken, NJ, USA: Wiley, 2023.
2. K. Smith, Hacking: How to Hack – The Ultimate Hacking Guide. Hacking Intelligence, n.d.
3. Charles P. Pfleeger and Shari Lawrence Pfleeger, Security in Computing, 6th ed. Hoboken, NJ, USA: Pearson, 2023.
4. Chuck Easttom, Computer Security Fundamentals, 4th ed. Hoboken, NJ, USA: Pearson, 2022.
5. M. Gregg, Build Your Own Security Lab. New Delhi, India: Wiley India, 2008.

**Online Resources**

1. NPTEL Ethical Hacking Course : <https://freevideolectures.com/course/4070/nptel-ethical-hacking>
2. OWASP Top 10 Web Vulnerabilities : <https://owasp.org/www-project-top-ten/>
3. Kali Linux Tutorial Guide : <http://www.opentechinfo.com/learn-use-kali-linux/>.
4. PentesterLab Hands-on Labs : <https://pentesterlab.com/>
5. OWASP Top 10 Security Risks : <https://owasp.org/www-project-top-ten/>

**ISE:**

- To be conducted in any of these forms - Assignment/ Quiz/ Presentation/ Class Test/ Case study etc. of 20 marks.
- ISE 20 marks = 05 marks for attendance + 15 marks for activities.

**MSE:**

- To be conducted as written examination for 20 marks (on 40% - 50% syllabus).

**End Semester Examination:**

**\$ ESE of duration 03 hours are of 80 marks and scaled to 60.**

1. Question paper will comprise 03 questions.
2. Question 1(20 marks): - Solve any 04 out of 06. All questions carry 05 marks each.
3. Question 2 (40 marks): - Solve any 04 out of 06. All questions carry 10 marks each.
4. Question 3(20 marks): - Solve any 04 out of 06. All questions carry 05 marks each.
5. All COs should be mapped as per the weightage in the syllabus

| Course Code | Course Name                 | Teaching Scheme (Hrs.) |           |          | Credits Assigned |           |          |       |
|-------------|-----------------------------|------------------------|-----------|----------|------------------|-----------|----------|-------|
|             |                             | Theory                 | Practical | Tutorial | Theory           | Practical | Tutorial | Total |
| MDMC6013    | Natural Language Processing | 3                      | --        | --       | 3                | --        | --       | 3     |

| Course Code | Course Name                 | Examination Scheme |     |                   |      |      |       |
|-------------|-----------------------------|--------------------|-----|-------------------|------|------|-------|
|             |                             | Theory Marks       |     |                   | CIAP | ESEP | Total |
|             |                             | Course Assessment  |     | ESE <sup>\$</sup> |      |      |       |
|             |                             | ISE                | MSE |                   |      |      |       |
| MDMC6013    | Natural Language Processing | 20                 | 20  | 60                | --   | --   | 100   |

**Pre- requisite:**

1. CEC501: Theoretical Computer Science

**Program Outcomes Addressed**

1. PO1: Engineering Knowledge
2. PO2: Problem Analysis
3. PO3: Design/Development of Solutions
4. PO4: Conduct Investigations of Complex Problems
5. PO11: Life-Long Learning

**Course Objectives:**

1. To introduce key concepts, linguistic foundations, text pre-processing and core challenges in Natural Language Processing
2. To build student competency in morphological analysis and language modeling.
3. To explain syntactic structures, tagging and parsing methods for linguistic analysis.
4. To introduce key semantic and discourse concepts for understanding word meaning and document structure.
5. To explore the essential architectures and training approaches underlying large language models.
6. To examine key NLP applications such as NER, QA, machine translation, and modern large-scale language models.

**Course Outcomes: Learners will be able to**

1. Apply foundational NLP concepts and basic text-processing techniques to analyze language data and develop simple NLP applications.
2. Apply finite-state techniques and N-gram models to analyze morphology and evaluate language models effectively.
3. Analyze POS tagging methods and parsing techniques to interpret and construct accurate syntactic structures of natural language text.
4. Interpret semantic and discourse techniques to understand text meaning and resolve references.
5. Describe key LLM architectures and evaluation methods used in modern NLP systems.
6. Identify major NLP applications and modern LLMs used for real-world language

understanding tasks.

| Module No. | Unit No.   | Topics                                                                                                                                                                                                      | Hrs.      | CO         |
|------------|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|------------|
| <b>1.0</b> |            | <b>Introduction to NLP and Text Processing</b>                                                                                                                                                              | <b>06</b> |            |
|            | <b>1.1</b> | What is Natural Language Processing (NLP)? History of NLP, Generic NLP System, Levels of NLP, Ambiguity and Layers of NLP.<br>Challenges of NLP, Processing Indian Languages, Applications of NLP.          |           | <b>CO1</b> |
|            | <b>1.2</b> | Basic Text Processing: Tokenization, Stopword Removal, Stemming and Lemmatization, Regular Expressions                                                                                                      |           |            |
|            |            | <b>Self-learning Topics:</b> Tools for regional languages pre-processing and other functionalities.                                                                                                         |           |            |
| <b>2.0</b> |            | <b>Word Level Analysis</b>                                                                                                                                                                                  | <b>06</b> |            |
|            | <b>2.1</b> | Survey of English Morphology, Inflectional Morphology, Derivational Morphology.                                                                                                                             |           | <b>CO2</b> |
|            | <b>2.2</b> | Morphological Models: Dictionary lookup, finite state morphology; Morphological parsing with FST (Finite State Transducer); Lexicon free FST Porter Stemmer algorithm                                       |           |            |
|            | <b>2.3</b> | Language models- N-gram models and smoothing techniques: Laplace smoothing, Good-Turing Discounting, Evaluating language models- perplexity, cross-entropy                                                  |           |            |
|            |            | <b>Self-learning Topics:</b> Noisy channel models, Edit distances, Advance Issues in Language Modelling                                                                                                     |           |            |
| <b>3.0</b> |            | <b>Syntax Analysis</b>                                                                                                                                                                                      | <b>10</b> |            |
|            | <b>3.1</b> | Part-of-speech Tagging: Illustration of Ambiguity in POS, Table Look-up-based and Rule-based POS, Statistical POS Tagging: Hidden Markov Models (HMM) for POS tagging, Viterbi decoding algorithm; Chunking |           | <b>CO3</b> |
|            | <b>3.2</b> | Context-Free Grammars (CFG) and parse trees; Linguistics of Parsing                                                                                                                                         |           |            |
|            | <b>3.3</b> | Algorithmics of Parsing, Constituency Parsing: Rule Based (Top-Down, Bottom-Up, CYK)                                                                                                                        |           |            |
|            | <b>3.4</b> | Statistical Parsing, Dependency Parsing and Neural Parsing                                                                                                                                                  |           |            |
|            |            | <b>Self-learning Topics:</b> Evaluating parsers, Parsers based language modelling, regional languages POS tree banks                                                                                        |           |            |
| <b>4.0</b> |            | <b>Semantic and Discourse Processing</b>                                                                                                                                                                    | <b>08</b> |            |
|            | <b>4.1</b> | Introduction, Meaning Representation; Lexical Semantics; Study of Various language dictionaries like WordNet, Lexical Relations                                                                             |           | <b>CO4</b> |
|            | <b>4.2</b> | Word Embeddings: Word2Vec, CBOW, Skip-gram, GloVe                                                                                                                                                           |           |            |
|            | <b>4.3</b> | Word Sense Disambiguation (WSD) methods: Lesk algorithm<br>Document representation: TF-IDF, Doc2Vec                                                                                                         |           |            |
|            | <b>4.4</b> | Discourse Structure, Cohesion, Discourse Coherence &                                                                                                                                                        |           |            |

|            |            |                                                                                                                                                                                                                                                           |           |            |
|------------|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|------------|
|            |            | Structure , Reference resolution, Reference phenomena, Anaphora resolution using Hobbs algorithm                                                                                                                                                          |           |            |
|            |            | <b>Self-learning Topics:</b> Dictionaries for regional languages, Distributional Semantics, Topic Models , Multimodal Discourse (Text + Image, Text + Video)                                                                                              |           |            |
| <b>5.0</b> |            | <b>Modern NLP with Transformers</b>                                                                                                                                                                                                                       | <b>05</b> |            |
|            | <b>5.1</b> | Introduction to Large Language Models (LLM), Fundamental components of the Transformer model                                                                                                                                                              |           | <b>CO5</b> |
|            | <b>5.2</b> | Transformer Architecture and Self-Attention Mechanism, Encoder–Decoder architecture, Introduction to pre-training and fine-tuning paradigms, Pretrained models (BERT, GPT, T5) and fine-tuning, Positional Encoding. Evaluation metrics (BLEU, ROUGE, F1) |           |            |
|            |            | <b>Self-learning Topics:</b> Transformer Variants-ALBERT, XLNet, Long former.                                                                                                                                                                             |           |            |
| <b>6.0</b> |            | <b>Applications of NLP</b>                                                                                                                                                                                                                                | <b>04</b> |            |
|            | <b>6.1</b> | Named Entity Recognition (NER) , Question Answering System, Machine Translation                                                                                                                                                                           |           | <b>CO6</b> |
|            | <b>6.2</b> | Advanced NLP applications: GPT- 4, Llama-3, Claude-3, Mistral and Gemini.                                                                                                                                                                                 |           |            |
|            |            | <b>Self-learning Topics:</b> Use of NLP in Recommender Systems, Federated Learning for NLP Applications, Develop Chatbot Applications.                                                                                                                    |           |            |
|            |            | <b>Total</b>                                                                                                                                                                                                                                              | <b>39</b> |            |

#### Textbooks:

1. Daniel Jurafsky, James H. and Martin, Speech and Language Processing, Third Edition, Prentice Hall, 2026.
2. Christopher D.Manning and HinrichSchutze, Foundations of Statistical Natural Language Processing, MIT Press, 1999.
3. Pushpak Bhattacharyya and Aditya Joshi, Natural Language Processing, Wiley India Pvt. Ltd., Edition: 2023
4. Dr. Tanmoy Chakraborty, “Introduction to Large Language Models: Generative AI for Text” , Wiley (Wiley India). December 2024.

#### Reference books:

1. Siddiqui and Tiwary U.S., Natural Language Processing and Information Retrieval, Oxford University Press, 2008.
2. Daniel M Bikel and ImedZitouni — Multilingual natural language processing applications: from theory to practice, IBM Press, 2013.
3. Palash Goyal, Sumit Pandey, Karan Jain. Deep Learning for Natural Language Processing- 2018
4. Joseph Babcock, Raghav Bali, “Generative AI with Python and TensorFlow”, Packt Publishing 2021.

#### Online References:

1. NPTEL Course”Natural Language Processing”:  
[https://onlinecourses.nptel.ac.in/noc23\\_cs45/preview](https://onlinecourses.nptel.ac.in/noc23_cs45/preview)

2. NPTEL Swayam “Natural Language Processing” :  
<https://archive.nptel.ac.in/courses/106/106/106106211/>
3. Natural Language Toolkit Book: <https://www.nltk.org/book/>
4. Stanford Course”Natural Language Processing with Deep Learning”:  
<https://web.stanford.edu/class/cs224n/>

**Course Assessment:**

**ISE:**

- To be conducted in any of these forms - Assignment/ Quiz/ Presentation/ Class Test/ Case study etc. of 20 marks.
- ISE 20 marks = 05 marks for attendance + 15 marks for activities.

**MSE:**

- To be conducted as written examination for 20 marks (on 40% - 50% syllabus)

**End Semester Examination:**

**\$ ESE of duration 03 hours are of 80 marks and scaled to 60.**

1. Question paper will comprise of 03 questions.
2. Question1(20 marks): - Solve any 04 out of 06. All questions carry 05 marks each.
3. Question 2 (40 marks): - Solve any 04 out of 06. All questions carry 10 marks each.
4. Question3(20 marks):- Solve any 04 out of 06. All questions carry 05 marks each.
5. All COs should be mapped as per the weightage in the syllabus.

| Course Code      | Course Name                                         | Teaching Scheme (Hrs.) |           |          | Credits Assigned |           |          |           |
|------------------|-----------------------------------------------------|------------------------|-----------|----------|------------------|-----------|----------|-----------|
|                  |                                                     | Theory                 | Practical | Tutorial | Theory           | Practical | Tutorial | Total     |
| <b>MDMC 6053</b> | <b>System Programming and compiler Construction</b> | <b>03</b>              | <b>-</b>  | <b>-</b> | <b>03</b>        | <b>-</b>  | <b>-</b> | <b>03</b> |

| Corse Code | Course Name                                  | Examination Scheme |     |                   |      |      |       |
|------------|----------------------------------------------|--------------------|-----|-------------------|------|------|-------|
|            |                                              | Theory Marks       |     |                   | CIAP | ESEP | Total |
|            |                                              | Course Assessment  |     | ESE <sup>\$</sup> |      |      |       |
|            |                                              | ISE                | MSE |                   |      |      |       |
| MDMC6053   | System Programming and compiler Construction | 20                 | 20  | 60                | --   | --   | 100   |

**Pre-requisite:**

1. CSEC402 :Operating System.
2. CSEC305: Computer Organization and Architecture

**Program Outcome mapped:**

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO3: Design/Development of solutions
4. PO7: Ethics
5. PO11: Life-Long Learning

**Course Objectives: Learners will be enable**

- 1.To introduce role and functionality of various system programs over application programs
- 2.To explore basic concepts, structure and design of assemblers, macro processors, linkers and loaders
- 3.To explore the need to follow the syntax in writing an application program
4. To investigate the analysis phase of compiler design to understand the programmer 's requirements without ambiguity
- 5.To synthesize the outcomes of analysis phase to produce the object code that is efficient in terms of space and execution time, by applying code optimization techniques.
6. To underastand the working of parallel compilers

**Course Outcomes: Learners will be able to**

1. Identify the relevance of different system programs and understand various data structures used for design of assembler.
2. Discuss microprocessor design and distinguish between different loaders and linkers and their contribution in developing efficient user applications
3. Analyse lexical analysis and Syntax and semantic analysis phases of compiler.
4. Generate Intermediate code as part of synthesis phase.
5. Illustrate Code optimizations, code generation and error detection.
6. Apply parallelization in compiler in sorting arrays.

| Module No. | Unit No. | Topics                                                                                                                                                                                  | Hrs. | Mapped to CO |
|------------|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|--------------|
| 1          |          | <b>Introduction to System Programming and Assembler design</b>                                                                                                                          | 07   |              |
|            | 1.1      | Concept of System Software, Goals of system software, system program and system programming,                                                                                            |      | CO1          |
|            | 1.2      | Introduction to various system programs                                                                                                                                                 |      |              |
|            | 1.3      | Elements of Assembly Language programming, Assembly scheme, pass structure of assembler,                                                                                                |      |              |
|            | 1.4      | Assembler Design: Two pass assembler X86 processor, data structures used                                                                                                                |      |              |
|            |          | <b>Self-Learning Topics:</b> X86 Addressing Modes & Instruction Format, Relocation and Linking Concepts                                                                                 |      |              |
| 2          |          | <b>Macros, Linker and Loader</b>                                                                                                                                                        | 06   |              |
|            | 2.1      | Introduction, Macro definition and call, Design of Two pass macro processor, data structures used                                                                                       |      | CO2          |
|            | 2.2      | Introduction, functions of loaders, Relocation and Linking concept, Different loading schemes                                                                                           |      |              |
|            | 2.3      | Direct Linking Loader, Dynamic linking and loading                                                                                                                                      |      |              |
|            |          | <b>Self-Learning Topics:</b> Advanced Macro Expansion Techniques, Loader implementation issues                                                                                          |      |              |
| 3          |          | <b>Introduction to Compilers and Analysis Phase:</b>                                                                                                                                    | 11   |              |
|            | 3.1      | Overview of compilers, difference between compilers and interpreters, structure of a compiler                                                                                           |      | CO3          |
|            | 3.2      | Role of lexical analyzer, Input buffering, specification and recognition of tokens                                                                                                      |      |              |
|            | 3.3      | Context-free grammars, Parsing techniques : Top Down and Bottom-Up approach, Recursive Descent Parser , Predictive Parser, LL(1) Parser                                                 |      |              |
|            | 3.4      | LR Parsers - SLR Parser - Canonical LR Parser - LALR Parser. Operator Precedence Parser                                                                                                 |      |              |
|            | 3.5      | Syntax-directed definitions, evaluation orders, and type checking                                                                                                                       |      |              |
|            |          | <b>Self-Learning Topics:</b> Ambiguity in grammars and ambiguity removal , Operator precedence table construction                                                                       |      |              |
| 4          |          | <b>Intermediate Code Generation:</b>                                                                                                                                                    | 05   |              |
|            | 4.1      | Intermediate Code, Intermediate code generation methods                                                                                                                                 |      | CO4          |
|            | 4.2      | Three Address Code representation                                                                                                                                                       |      |              |
|            | 4.3      | <b>Self-Learning Topics:</b> Attribute Grammars (Synthesized & Inherited Attributes), 3AC generation for loops and conditionals                                                         |      |              |
| 5          |          | <b>Code optimization and generation</b>                                                                                                                                                 | 06   |              |
|            | 5.1      | Code Optimization: Sources of optimization, Loop Optimization: Unrolling, Fusion, Invariant Code Motion, optimization of basic blocks, loops, dataflow analysis, Directed Acyclic Graph |      | CO5          |

|              |     |                                                                                                                |           |            |
|--------------|-----|----------------------------------------------------------------------------------------------------------------|-----------|------------|
|              | 5.2 | Design of a code generator, run-time storage management, target machine architecture.                          |           |            |
|              | 5.3 | Error Detection and Recovery: Lexical, syntactic, and semantic errors; error recovery strategies.              |           |            |
|              |     | <b>Self-Learning Topics:</b> RISC vs CISC and impact on code generation                                        |           |            |
| <b>6</b>     |     | <b>Parallel Compiler:</b>                                                                                      | <b>04</b> |            |
|              | 6.1 | Parallel compilation, parallel parsing, semantic analysis, and optimization techniques                         |           | <b>CO6</b> |
|              | 6.2 | Parallel Code Generation: Code generation for parallel architectures, synchronization, instruction scheduling. |           |            |
|              |     | <b>Self-Learning Topics:</b> Loop parallelization techniques, Dependence analysis for parallel compilation     |           |            |
| <b>Total</b> |     |                                                                                                                | <b>39</b> |            |

### Textbooks:

- 1.D. M Dhamdhere: Systems programming and Operating Systems, Tata McGraw Hill, **SBN:** 0074635794,1999
- 2 A. V. Aho, R. Shethi, Monica Lam, J.D. Ulman: Compilers Principles, Techniques and Tools, Pearson Education, Second Edition ,ISBN 978-81317-2101-8,, 2008
- 3.Modern Compiler Design, by Dick Grune, Kees van Reeuwijk, Henri E. Bal, Criel J. H. Jacobs, Koen Langendoen, 2nd ed,, ISBN 978 1461 446989, Springer (2012).
4. R. Allen and K. Kennedy, *Optimizing Compilers for Modern Architectures: A Dependence-Based Approach*. San Francisco, CA, USA: Morgan Kaufmann, 2001

### Reference Books:

- 1.Manoj Chandak and Khushboo Khurana”Compiler Design”(2018), Universities Press, **ISBN:** 978-9386235640,2018
2. Randy Allen & Ken Kennedy, “Optimizing Compilers for Modern Architectures”, ISBN 81-8147-366-3, Morgan Kaufmann, Elsevier, 2002

### Online References

- 1.NPTEL Course: <http://www.nptelvideos.in/2012/11/compiler-design.html>
- 2.Project Centered Coursera Course: <https://www.coursera.org/lecture/nand2tetris2/unit-4-1-syntax-analysis-5pC2Z>

### Course Assessment:

#### ISE:

- To be conducted in any of these forms - Assignment/ Quiz/ Presentation/ Class Test/ Case study etc. of 20 marks.
- ISE 20 marks = 05 marks for attendance + 15 marks for activities.

**MSE:** To be conducted as a written examination for 20 marks (on 40% - 50% syllabus)

**End Semester Examination**

**\$ ESE of duration 03 hours are of 80 marks and scaled to 60.**

1. Question paper will comprise of 03 questions.
2. Question1(20 marks): - Solve any 04 out of 06. All questions carry 05 marks each.
3. Question 2 (40 marks): - Solve any 04 out of 06. All questions carry 10 marks each.
4. Question3(20 marks) :- Solve any 04 out of 06. All questions carry 05 marks each.
5. All COs should be mapped as per the weightage in the syllabus.

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|                                                                                                                                                                        |                                                                                                                                                                                                                                                    |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  <p><b>SIES</b> Graduate School of Technology (Autonomous)<br/>RISE WITH EDUCATION</p> | <p align="center"><b>SIES Graduate School of Technology</b><br/> <b>Department of Computer Science and Engineering</b><br/> <b>(Internet of Things and Cyber Security including Blockchain Technology)</b><br/> <b>Bachelor of Engineering</b></p> |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

| Course Code | Course Name                                            | Teaching Scheme (Hrs.) |           |          | Credits Assigned |           |          |       |
|-------------|--------------------------------------------------------|------------------------|-----------|----------|------------------|-----------|----------|-------|
|             |                                                        | Theory                 | Practical | Tutorial | Theory           | Practical | Tutorial | Total |
| MDMC6063    | Organizational Behaviour and Human Resource Management | 03                     | --        | 01       | 03               | --        | 01       | 04    |

| Course Code | Course Name                                            | Examination Scheme |     |       |      |      |       |
|-------------|--------------------------------------------------------|--------------------|-----|-------|------|------|-------|
|             |                                                        | Theory Marks       |     |       | CIAP | ESEP | Total |
|             |                                                        | Course Assessment  |     | ESE\$ |      |      |       |
|             |                                                        | ISE                | MSE |       |      |      |       |
| MDMC 6063   | Organizational Behaviour and Human Resource Management | 20                 | 20  | 60    | 25   | --   | 125   |

**Pre- requisite:**

1. Basic understanding of communication and teamwork in project environments
2. Curiosity to learn about human behavior and roles in organizations

**Program Outcomes Addressed**

1. PO2: Problem Analysis
2. PO7: Global and Ethical Practices
3. PO8: Collaborative Teamwork
4. PO9: Communication
5. PO10: Project Management and Finance
6. PO11: Lifelong Learning

**Course Objectives:**

1. To explain fundamental concepts of organizational behaviour, including perception, motivation, leadership, teamwork, and communication, relevant to technical and professional environments.
2. To help students understand individual and group behaviour and develop the ability to apply behavioural principles for effective collaboration in engineering teams.
3. To enable students to apply HRM concepts such as recruitment, training, performance appraisal, and employee engagement in engineering and project-based organizations.
4. To develop skills in conflict resolution, negotiation, and decision-making, preparing students to handle workplace challenges in technical settings.
5. To build the ability to analyze organizational culture and structure, and understand how these factors influence innovation, productivity, and technology-driven work environments.
6. To prepare students to become effective engineering professionals by cultivating leadership, ethical behaviour, interpersonal skills, and a people-oriented mindset essential for managing diverse teams.

**Course Outcomes: Learners will be able to**

1. Relate the key concepts of organizational behaviour and human resource management relevant to engineering workplaces.
2. Understand motivation, communication, and leadership theories to improve individual and team performance in technical environments.
3. Apply workplace situations, identify behavioural issues, and evaluate their impact on engineering teams and project outcomes.
4. Analyse HR practices such as recruitment, performance appraisal, and training, and justify their relevance in engineering industries.
5. Evaluate solutions or strategies for conflict resolution, teamwork enhancement, and employee engagement in engineering projects.
6. Create and demonstrate ethical behaviour, interpersonal skills, and professional conduct, and evaluate their role in shaping an effective organizational culture.

| Module No. | Unit No. | Topics                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Hrs.     | Mapped to Course Outcome |
|------------|----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------------------|
| <b>1.0</b> | <b>1</b> | <b>Introduction to Organizational Behaviour and Interpersonal skills</b>                                                                                                                                                                                                                                                                                                                                                                                                         | <b>5</b> |                          |
|            |          | Meaning and significance of OB, functions, roles and skills related to management; contributing disciplines to the field of OB; challenges and opportunities for OB. Importance of interpersonal skills for engineers; verbal and non-verbal communication; active listening; giving and receiving feedback; building trust and rapport; handling difficult conversations                                                                                                        |          | <b>CO1, CO2</b>          |
|            |          | <b>Self-learning Topics:</b> Contributing disciplines to OB, Challenges and opportunities in OB, Importance of interpersonal skills for engineers                                                                                                                                                                                                                                                                                                                                |          |                          |
| <b>2.0</b> | <b>2</b> | <b>Personality, Perception and Decision Making</b>                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>6</b> |                          |
|            |          | Meaning and determinants of personality; major personality traits and attributes; Big Five Model; Job Fit Theory; measuring personality; managing emotions at the workplace. Meaning of perception; factors influencing perception and attitude; Attribution Theory; errors in attribution; link between perception and individual decision making.                                                                                                                              |          | <b>CO2</b>               |
|            |          | <b>Self-learning Topics:</b> Meaning of perception; factors influencing perception and attitude                                                                                                                                                                                                                                                                                                                                                                                  |          |                          |
| <b>3.0</b> | <b>3</b> | <b>Values, Attitudes, Job Satisfaction, Learning and Motivation</b>                                                                                                                                                                                                                                                                                                                                                                                                              | <b>6</b> |                          |
|            |          | Definition and types of values; definition and types of attitudes; definition and measurement of job satisfaction; meaning of learning; methods of learning at work. Definition of motivation; theories of motivation (Theory X & Theory Y, Maslow's Need Hierarchy, Two-factor theory, ERG theory, Goal-setting theory, Reinforcement theory, Equity theory, Expectancy theory); motivation from theory to application; link between skill-based plans and motivation theories. |          | <b>CO2</b>               |
|            |          | <b>Self-learning Topics:</b> Definition and types of attitudes; definition and measurement of job satisfaction; meaning of learning; methods of learning at work.                                                                                                                                                                                                                                                                                                                |          |                          |

|  <b>Graduate School of Technology (Autonomous)</b><br><b>RISE WITH EDUCATION</b> |          | <b>SIES Graduate School of Technology</b><br><b>Department of Computer Science and Engineering</b><br><b>(Internet of Things and Cyber Security including Blockchain Technology)</b><br><b>Bachelor of Engineering</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |           |                 |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|-----------------|
| <b>4.0</b>                                                                                                                                                       | <b>4</b> | <b>Leadership Theories, Styles &amp; Team Influence, Applied Leadership Skills for Engineering Teams</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>6</b>  |                 |
|                                                                                                                                                                  |          | Concept of leadership; leader vs manager; leadership traits and competencies; overview of major leadership theories (trait, behavioural, contingency/situational); leadership styles and their relevance in technical teams. Leading teams; delegation and empowerment; decision-making and problem-solving as a leader; power and influence; ethical leadership; developing one's own leadership plan.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |           | <b>CO2, CO3</b> |
|                                                                                                                                                                  |          | <b>Self-learning Topics:</b> Differences between a leader and a manager.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |           |                 |
| <b>5.0</b>                                                                                                                                                       | <b>5</b> | <b>Understanding Group Behavior and Teams, Conflicts in the Organization- Organizational Culture and Stress and Organizational Change</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <b>10</b> |                 |
|                                                                                                                                                                  |          | Definition of groups and teams; Stages of group and team development; Group structure: roles, norms, status; Group tasks and decision making; Types of teams - problem-solving, self-managed, cross-functional, virtual etc.; Features of effective teams; Creating and managing effective teams in engineering projects. Definition of conflict; transitions in conflict thought; functional and dysfunctional conflict; the conflict process; negotiation process; bargaining strategies (distributive & integrative).<br><b>Organizational Culture and Stress</b> – Definition of organizational culture; types of culture; functions of culture; culture as an asset and liability; creating and sustaining culture; learning organizational culture; Hofstede's model of culture;<br><b>Organizational Stress</b> – definition of stress; understanding stress and its consequences; sources of stress; managing stress. Meaning of change; forces of change; levels of change; resistance to change; process of change; role of managers in facilitating change. |           | <b>CO4, CO5</b> |
|                                                                                                                                                                  |          | <b>Self-learning Topics:</b> Group structure: roles, norms, status; Group tasks and decision making.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |           |                 |
| <b>6.0</b>                                                                                                                                                       | <b>6</b> | <b>Introduction to Human Resource Management &amp; Talent Acquisition Performance Management, Development &amp; Employee Engagement</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>6</b>  |                 |
|                                                                                                                                                                  |          | Meaning, scope and objectives of HRM; role of HR in organizations and specifically in engineering / project-based firms; HR planning; job analysis and job descriptions; recruitment and selection basics.<br>Training and development; performance management and feedback; basics of compensation and rewards; employee engagement and welfare; HR's role in supporting career development of engineers.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |           | <b>CO4, CO6</b> |
|                                                                                                                                                                  |          | <b>Self-learning Topics:</b> Meaning, scope and objectives of HRM, ; HR's role in supporting career development of engineers.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |           |                 |
|                                                                                                                                                                  |          | <b>Tutorial: Case studies, role play and quiz on organizational behavior and HRM</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |           |                 |
|                                                                                                                                                                  |          | <b>Total</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>39</b> |                 |

**Textbooks:**

1. Robbins, S. P., & Judge, T. A. (2022). *Organizational behavior* (19th ed.). Pearson.
2. Aswathappa, K. (2018). *Organizational behaviour* (12th ed.). McGraw Hill Education.
3. Dessler, G. (2020). *Human resource management* (16th ed.). Pearson.
4. Armstrong, M. (2021). *Armstrong's handbook of human resource management practice* (16th ed.). Kogan Page.

**Reference books:**

1. Luthans, F. (2021). *Organizational behavior: An evidence-based approach* (14th ed.). McGraw Hill.
2. Schermerhorn, J. R., Hunt, J. G., & Osborn, R. N. (2020). *Organizational behavior* (14th ed.). Wiley.
3. Mondy, R. W., & Martocchio, J. J. (2016). *Human resource management* (14th ed.). Pearson.
4. Mathis, R. L., Jackson, J. H., & Valentine, S. R. (2019). *Human resource management* (15th ed.). Cengage Learning.

**Course Assessment:**

**ISE:**

- To be conducted in any of these forms - Assignment/ Quiz/ Presentation/ Class Test/ Case study etc. of 20 marks.
- ISE 20 marks = 05 marks for attendance + 15 marks for activities.

**MSE:**

- To be conducted as written examination for 20 marks (on 40% - 50% syllabus)

**End Semester Examination:**

**\$ ESE of duration 03 hours are of 80 marks and scaled to 60.**

1. Question paper will comprise of 03 questions.
2. Question1 (20 marks): - Solve any 04 out of 06. All questions carry 05 marks each.
3. Question 2 (40 marks): - Solve any 04 out of 06. All questions carry 10 marks each.
4. Question 3 (20 marks):- Solve any 04 out of 06. All questions carry 05 marks each.
5. All COs should be mapped as per the weightage in the syllabus.

**CIAP (25-Marks):**

At least 06 Tutorials covering entire syllabus must be given during the "Class Wise Tutorial".

| Course Code | Course Name    | Teaching Scheme (Hrs.) |           |          | Credits Assigned |           |          |       |
|-------------|----------------|------------------------|-----------|----------|------------------|-----------|----------|-------|
|             |                | Theory                 | Practical | Tutorial | Theory           | Practical | Tutorial | Total |
| CSEPE C6011 | Industrial IoT | 03                     | -         | -        | 03               | -         | -        | 03    |

| Course Code | Course Name    | Examination Scheme |     |                   |      |      |       |
|-------------|----------------|--------------------|-----|-------------------|------|------|-------|
|             |                | Theory Marks       |     |                   | CIAP | ESEP | Total |
|             |                | Course Assessment  |     | ESE <sup>\$</sup> |      |      |       |
|             |                | ISE                | MSE |                   |      |      |       |
| CSEPEC 6011 | Industrial IoT | 20                 | 20  | 60                | --   | --   | 100   |

**Pre-requisite :**

1. CSEC601: IoT Architecture and Protocols

**Program Outcomes addressed:**

1. PO1: Engineering Knowledge
2. PO2: Problem Analysis
3. PO3: Design/Development of Solution
4. PO6: The Engineer and The World
5. PO8: Individual and Collaborative Teamwork
6. PO11: Life-Long Learning

**Course Objectives:**

1. To introduction to IoT, Overview of IoT Building Blocks.
2. To build small IoT applications using sensors, actuators, microcontrollers, and cloud.
3. To learn commonly used IoT Simulation Hardware platforms.
4. To understand different Communication Technologies used in IoT.
5. To development of application-level protocol and Security of IoT Ecosystem.
6. To Understand IoT applications in different domains.

**Course Outcomes: Learners will be able to**

1. Explain the applications/devices, protocols and communication models of IoT
2. Demonstrate IoT applications using sensors, actuators, microcontrollers, and cloud.
3. Select commonly used iot simulation hardware platforms.
4. Application of interfacing and communication technologies for IoT .
5. Illustrate IoT application development and security of iot ecosystem.
6. Evaluate present and future domain specific applications of IoT ecosystem.

| Module No. | Unit No.   | Topics                                                                                                                                                                                                                                                                                                                                                                                                                 | Hrs.      | CO         |
|------------|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|------------|
| <b>1.0</b> |            | <b>Introduction to IoT and Building Blocks</b>                                                                                                                                                                                                                                                                                                                                                                         | <b>07</b> |            |
|            | <b>1.1</b> | <b>Overview, History, and Characteristics of IoT :</b> Overview: History, Definition and Characteristics, Connectivity Terminologies, Building blocks, Types of technologies used in IoT System, Baseline Technologies (Machine-to-Machine (M2M) communications, Cyber-Physical-Systems (CPS)), IoT Vs M2M,                                                                                                            |           | <b>CO1</b> |
|            | <b>1.2</b> | <b>IoT Architecture, Building Blocks, and Design Methodology:</b> IoT enabled Technologies, IoT Levels and Templates, Design Methodology, The Physical Design Vs Logical Design of IoT, Functional blocks of IoT and Communication Models/Technologies, Development Tools used in IoT, IoT Architecture and Protocols, Various Platforms for IoT, Real time Examples of IoT                                            |           |            |
|            | <b>1.3</b> | <b>Applications, Challenges, and Security Issues in IoT</b> Challenges in IoT, The process flow of an IoT application, Evolution of Connected Devices, Applications of IoT, IoT Enablers, Overview of Governance, Privacy and Security Issues.                                                                                                                                                                         |           |            |
|            |            | <b>Self-Learning:</b> IoT Architecture: Levels, Functional Blocks & Communication Models                                                                                                                                                                                                                                                                                                                               |           |            |
| <b>2.0</b> |            | <b>Sensors, Actuators, and Controllers</b>                                                                                                                                                                                                                                                                                                                                                                             | <b>07</b> |            |
|            | <b>2.1</b> | <b>Principles of Sensors and Transducers :</b> Measuring physical and virtual quantities in digital world, Overview of Sensors working, Analog Vs Digital Sensors, Wired Vs Wireless Sensors, Types of Sensors, Types of Converters                                                                                                                                                                                    |           | <b>CO2</b> |
|            | <b>2.2</b> | <b>Types of Transducers and Actuator :</b> Controlling Hardware, Types of Controller, Role of microcontroller as gateway to interfacing sensors and actuators, Microcontroller Vs Microprocessor, Type of microcontrollers in embedded System                                                                                                                                                                          |           |            |
|            |            | <b>Self-Learning:</b> Sensors, Transducers & Actuators in IoT Systems                                                                                                                                                                                                                                                                                                                                                  |           |            |
| <b>3.0</b> |            | <b>IoT Hardware Platforms and Interfacing</b>                                                                                                                                                                                                                                                                                                                                                                          | <b>07</b> |            |
|            | <b>3.1</b> | <b>IoT supported Hardware platforms:</b> Introduction to IoT Simulation Environment and Devices (Raspberry Pi, Espressif Processors, Arduino), Architecture, Setup, IDE, Installation, Interfaces (serial, SPI, I2C), Programming with focus on interfacing for reading input from pins, connecting external gadgets/sensors/actuators, Controlling and Displaying Output, Libraries, Basics of Embedded C programming |           | <b>CO3</b> |
|            | <b>3.2</b> | <b>Interfacing:</b> Interfacing Input, Intermediate, Output and Display                                                                                                                                                                                                                                                                                                                                                |           |            |

|            |            |                                                                                                                                                                                                                                                                                                                                                                                                                                                             |           |            |
|------------|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|------------|
|            |            | Sensors, Converters, Actuators, Controlling Hardware, Controllers and Network Devices,                                                                                                                                                                                                                                                                                                                                                                      |           |            |
|            | <b>3.3</b> | <b>IoT Architecture:</b> Building architecture and Open-source architecture (OIC), Main design principles and needed capabilities, An IoT architecture outline, Standards Considerations                                                                                                                                                                                                                                                                    |           |            |
|            |            | <b>Self-Learning:</b> IoT Hardware Platforms, Interfacing & Architecture                                                                                                                                                                                                                                                                                                                                                                                    |           |            |
| <b>4.0</b> |            | <b>Communication and Cloud Integration</b>                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>07</b> |            |
|            | <b>4.1</b> | <b>Communication:</b> Overview and Working of Controlled Systems, Connectivity models - TCP/IP Vs OSI model, IoT Communication Models, IoT Communication APIs, Serial Vs Parallel Communication, Wires Vs Wireless Communication, their Technologies and Hardware                                                                                                                                                                                           |           | <b>CO4</b> |
|            | <b>4.2</b> | <b>IoT Communication Protocols:</b> Protocol Standardization for IoT, Role of M2M in IoT, M2M Value Chains, IoT Value Chains, M2M and WSN Protocols (SCADA and RFID)                                                                                                                                                                                                                                                                                        |           |            |
|            | <b>4.3</b> | <b>Physical Servers and Cloud Platforms:</b> Web server, Posting sensor(s) data to web server, Introduction to Cloud Storage models and Communication APIs Webserver, API Virtualization concepts and Cloud Architecture, Advantages and limitations of Cloud computing, IoT Cloud platforms, Cloud services enabled devices, IoT security for consumer devices, Security levels, protecting IoT devices, Security, Privacy and Trust in IoT-Data-Platforms |           |            |
|            |            | <b>Self-Learning:</b> IoT Communication, Protocols & Cloud Integration                                                                                                                                                                                                                                                                                                                                                                                      |           |            |
| <b>5.0</b> |            | <b>Application Protocols and Security</b>                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>04</b> |            |
|            | <b>5.1</b> | <b>Application Protocols:</b> MQTT, REST/HTTP, SQL Back-end Application Designing (Designing with Apache, MySQL, HTML, CSS), Non SQL Back-end Application Designing (MongoDB Object Type Database, jQuery for UI Designing), JSON lib for data processing                                                                                                                                                                                                   |           | <b>CO5</b> |
|            | <b>5.2</b> | <b>Security:</b> Need of security in IoT, Security & Privacy during development, Privacy for IoT                                                                                                                                                                                                                                                                                                                                                            |           |            |
|            |            | <b>Self-Learning:</b> IoT Application Layer Protocols, Backend Design, and Security                                                                                                                                                                                                                                                                                                                                                                         |           |            |
| <b>6.0</b> |            | <b>Industrial and Domain Applications of IoT</b>                                                                                                                                                                                                                                                                                                                                                                                                            | <b>07</b> |            |
|            | <b>6.1</b> | <b>IoT applications for industry:</b> Future Factory Concepts, Brownfield IoT, Smart Objects, Smart Applications. Study of existing IoT platforms /middleware, Business, Manufacturing, Smart Homes/Home automation, Surveillance applications, Connected Vehicles, Agriculture, Healthcare, Activity                                                                                                                                                       |           |            |

|  |              |                                                                                                                                                                                                                                                                          |           |            |
|--|--------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|------------|
|  |              | Monitoring, Retail, Logistics, Security, Health and Lifestyle, Legal challenges,                                                                                                                                                                                         |           |            |
|  | <b>6.2</b>   | <b>IoT in Environmental Protection</b> Modern Day IoT Applications, Smart Grid, Smart Cities - Security, Privacy and Trust in IoT-Data-Platforms for Smart Cities, First Steps Towards a Secure Platform, Smartie Approach. Data Aggregation for the IoT in Smart Cities |           | <b>CO6</b> |
|  |              | <b>Self-Learning:</b> IoT Applications for Industry and Smart Ecosystems                                                                                                                                                                                                 |           |            |
|  | <b>Total</b> |                                                                                                                                                                                                                                                                          | <b>39</b> |            |

#### Textbooks:

1. S. Madakam and R. Ramaswamy, *Internet of Things (IoT): Fundamentals, Applications and Technologies*, Boca Raton, FL, USA: CRC Press, 2023.
2. A. Bahga and V. Madiseti, *Internet of Things: A Hands-On Approach*, 2nd ed., Hyderabad, India: Universities Press, 2022.
3. R. Buyya and A. V. Dastjerdi, *Internet of Things: Principles and Paradigms*, Cambridge, MA, USA: Elsevier, 2021.
4. D. Hanes, G. Salgueiro, P. Grossetete, R. Barton and J. Henry, *IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things*, 2nd ed., Indianapolis, IN, USA: Cisco Press, 2023.
5. P. K. Jain, *Industrial Internet of Things (IIoT): Concepts, Platforms and Applications*, New Delhi, India: McGraw Hill, 2022.

#### Reference books:

1. Arshdeep Bahga and Vijay Madiseti, *Internet of Things: A Hands-On Approach*, 2nd ed., Hyderabad, India: Universities Press, 2022.
2. David Hanes, G. Salgueiro, P. Grossetete, R. Barton, and J. Henry, *IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things*, 2nd ed., Indianapolis, IN, USA: Cisco Press, 2023.
3. G. P. Gupta, *Industrial Internet of Things and Cyber-Physical Systems*, Boca Raton, FL, USA: CRC Press, 2022.
4. Pethuru Raj and A. Raman, *Edge Computing: Concepts, Technologies and Applications*, Cham, Switzerland: Springer, 2022.
5. Sudeep Tanwar, *Blockchain for IoT Systems: Security and Privacy Paradigms*, Amsterdam, Netherlands: Elsevier, 2022.

#### Online References:

1. River Publishers: [https://www.riverpublishers.com/pdf/ebook/RP\\_E9788793102958.pdf](https://www.riverpublishers.com/pdf/ebook/RP_E9788793102958.pdf)
2. NPTEL: <https://nptel.ac.in/courses/106105166>
3. Udemy: <https://www.udemy.com/internet-of-things-iot-for-beginners-getting-started/>
4. Arduino Playground: <https://playground.arduino.cc/Projects/Ideas>
5. MegunoLink: <http://www.megunolink.com/articles/arduino-garage-door-opener>

**Course Assessment:**

**ISE:**

- To be conducted in any of these forms - Assignment/ Quiz/ Presentation/ Class Test/ Case study etc. of 20 marks.
- ISE 20 Marks = 05 Marks for attendance + 15 marks for Activities.

**MSE:**

- To be conducted as written examination for 20 marks (on 40% - 50% syllabus).

**End Semester Examination:**

**\$ ESE of duration 03 hours are of 80 marks and scaled to 60.**

1. Question paper will comprise of 03 questions.
2. Question1 (20 marks): - Solve any 04 out of 06. All questions carry 05 marks each.
3. Question 2 (40 marks): - Solve any 04 out of 06. All questions carry 10 marks each.
4. Question3 (20 marks): - Solve any 04 out of 06. All questions carry 05 marks each.
5. All COs should be mapped as per the weightage in the syllabus.



| Course Code | Course Name | Teaching Scheme (Hrs.) |           |          | Credits Assigned |           |          |       |
|-------------|-------------|------------------------|-----------|----------|------------------|-----------|----------|-------|
|             |             | Theory                 | Practical | Tutorial | Theory           | Practical | Tutorial | Total |
| CSEPEC6012  | NFT & DeFi  | 03                     | -         | -        | 03               | -         | -        | 03    |

| Course Code | Course Name | Examination Scheme |     |                  |      |      |       |
|-------------|-------------|--------------------|-----|------------------|------|------|-------|
|             |             | Theory Marks       |     |                  | CIAP | ESEP | Total |
|             |             | Course Assessment  |     | ESE <sup>s</sup> |      |      |       |
|             |             | ISE                | MSE |                  |      |      |       |
| CSEPEC 6012 | NFT & DeFi  | 20                 | 20  | 60               | --   | --   | 100   |

**Pre-requisite :**

1. CSEC 503: Introduction to Blockchain,

**Program Outcomes Addressed:**

1. PO1: Engineering Knowledge
2. PO2: Problem Analysis
3. PO3: Design/Development of Solution
4. PO4: Conduct Investigations of Complex Problems
5. PO6: The Engineer and The World
6. PO8: Individual and Collaborative Teamwork
7. PO11: Life-Long Learning

**Course Objectives:**

1. To understand NFTs and their practical applications.
2. To study asset tokenization and NFT standards/protocols.
3. To furnish information on marketplaces dedicated to the buying, selling, and creation of NFTs.
4. To understand the basic principles and concepts of DeFi.
5. To recognize the obstacles and potential advantages pertaining to security within the realm of DeFi.
6. To gain knowledge about various applications and uses of DeFi.

**Course Outcomes: Learners will be able to**

1. Grasp the fundamental principles and ideas behind NFTs.
2. Understand asset tokenization and various NFT standards and protocols.
3. Apply knowledge of NFT platforms for buying, selling, and creating NFTs.
4. Understand the core principles and structure of DeFi systems.
5. Identify DeFi security challenges and protection methods for protocols and user assets.
6. Implement and utilize DeFi principles and technologies in practical, real-world applications.

| Module No. | Unit No.   | Topics                                                                                                                                                                                                                                                                  | Hrs.      | CO         |
|------------|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|------------|
| <b>1.0</b> |            | <b>Introduction to NFTs</b>                                                                                                                                                                                                                                             | <b>07</b> |            |
|            | <b>1.1</b> | Definition of NFTs, history and development of NFTs, characteristics of NFTs, types of NFTs, difference between fungible and non fungible tokens, comparison of NFTs with other digital assets like cryptocurrencies,                                                   |           | <b>CO1</b> |
|            | <b>1.2</b> | Working of NFTs, advantages and opportunities of NFT investments, risks and challenges of NFT investments, buying and selling of NFTs, legal aspects of NFTs, potential applications and developments of NFTs. Self-study: Mapping of NFTs with potential applications. |           |            |
|            |            | <b>Self-Learning:</b> Mapping of NFTs with potential applications.                                                                                                                                                                                                      |           |            |
| <b>2.0</b> |            | <b>Tokenization &amp; NFT standards</b>                                                                                                                                                                                                                                 | <b>07</b> |            |
|            | <b>2.1</b> | Definition of tokenization, its advantages and disadvantages, process of tokenization, token offerings (initial coin offerings (ICOs), security token offerings (STOs), initial exchange offerings (IEOs), equity token offerings (ETOs),                               |           | <b>CO2</b> |
|            | <b>2.2</b> | Decentralized autonomous initial coin offerings (DAICOs)), ERC-721, ERC-1155, ERC-994, ERC-420, ERC-809                                                                                                                                                                 |           |            |
|            |            | <b>Self-Learning:</b> ERC-1201, ERC-998, NEO token standards                                                                                                                                                                                                            |           |            |
| <b>3.0</b> |            | <b>NFT marketplaces and platforms</b>                                                                                                                                                                                                                                   | <b>05</b> |            |
|            | <b>3.1</b> | Popular NFT marketplaces and platforms for buying, selling, and creating NFTs such as OpenSea, Rarible, SuperRare, Nifty Gateway, NBA Top Shot, creating and minting NFTs                                                                                               |           | <b>CO3</b> |
|            |            | <b>Self-Learning:</b> Other NFT marketplaces and platforms: Axie Infinity, Wax (Atomic Hub), Foundation, VeVe, Known Origin, Myth Market, Wrap-Up                                                                                                                       |           |            |
| <b>4.0</b> |            | <b>Fundamentals of DeFi</b>                                                                                                                                                                                                                                             | <b>09</b> |            |
|            | <b>4.1</b> | Financial markets (trading and exchanges), applications of blockchain in finance including insurance, post-trade settlement, financial crime prevention, and payments.                                                                                                  |           | <b>CO4</b> |
|            | <b>4.2</b> | What is DeFi, difference between TradFi/CeFi and DeFi, DeFi properties, DeFi layered architecture, DeFi primitives,                                                                                                                                                     |           |            |
|            | <b>4.3</b> | DeFi services (asset tokenization, decentralized exchanges (DEX)—Automated Market Maker (AMM), order book based DEX, DEX aggregators, flash loans, derivatives, money streaming, yield farming, insurance, and decentralized lending and borrowing), DeFi benefits      |           |            |

|            |            |                                                                                                                                                                                                           |           |            |
|------------|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|------------|
|            |            | <b>Self-Learning:</b> DEX examples: Uniswap, Bancor, WavesDEX, 0x, and IDEX. Applications of NFTs in DeFi: Collateralized loans, Fractional ownership, Gamification, etc.                                 |           |            |
| <b>5.0</b> |            | <b>DeFi Security</b>                                                                                                                                                                                      | <b>06</b> |            |
|            | <b>5.1</b> | Issues on all DeFi layers: Network attacks (Eclipse, DoS attacks), Consensus attacks (51% attacks, double-spending, selfish mining), Smart contract code bugs (reentrancy, authorization),                |           | <b>CO5</b> |
|            | <b>5.2</b> | DeFi Protocol Composability attacks (excessive arbitrage between pools, flash loans, oracle attacks), bridge attacks, Governance attacks                                                                  |           |            |
|            |            | <b>Self-Learning:</b> Open Research Challenges in DeFi                                                                                                                                                    |           |            |
| <b>6.0</b> |            | <b>DeFi Applications</b>                                                                                                                                                                                  | <b>05</b> |            |
|            | <b>6.1</b> | DeFi Apps, advantages of DeFi apps over traditional financial systems, Popular DeFi Apps: Instadapp (INST), Compound (COMP), PancakeSwap (CAKE), JustLend (JST), Convex Finance (CVX), NFT for metaverse. |           | <b>CO6</b> |
|            |            | <b>Self-Learning:</b> Curve (CRV), Uniswap (UNI), Aave (AAVE), Lido (LDO), Maker (MKR), MakerDAO                                                                                                          |           |            |
|            |            | <b>Total</b>                                                                                                                                                                                              | <b>39</b> |            |

#### Textbooks:

1. Shermin Voshmgir, *Token Economy: How the Web3 Reinvents the Internet*, 3rd ed., Berlin, Germany: Token Kitchen, 2023.
2. Campbell R. Harvey, Ashwin Ramachandran and Joey Santoro, *DeFi and the Future of Finance*, Hoboken, NJ, USA: Wiley, 2021.
3. Andreas M. Antonopoulos and Gavin Wood, *Mastering Ethereum: Building Smart Contracts and DApps*, Sebastopol, CA, USA: O'Reilly Media, 2018.
4. Arshdeep Bahga and Vijay Madisetti, *Blockchain Applications: A Hands-On Approach*, Hyderabad, India: Universities Press, 2022.

#### Reference books:

1. Chris Burniske and Jack Tatar, *Cryptoassets: The Innovative Investor's Guide to Bitcoin and Beyond*, New York, NY, USA: McGraw-Hill, 2017.
2. Imran Bashir, *Mastering Blockchain: A Deep Dive into Distributed Ledgers, Consensus Protocols, Smart Contracts, DApps, NFTs and DeFi*, 3rd ed., Birmingham, U.K.: Packt Publishing, 2023.
3. Paul Vigna and Michael J. Casey, *The Age of Cryptocurrency*, New York, NY, USA: St. Martin's Press, 2015.
4. Richard Kastelein, *Blockchain and Token Economy*, Amsterdam, Netherlands: Blockchain News, 2022.
5. Henning Diedrich, *Ethereum: Blockchains, Digital Assets, Smart Contracts, Decentralized Autonomous Organizations*, Wildfire Publishing, 2016.

#### Online References

1. NPTEL: [https://onlinecourses.nptel.ac.in/noc22\\_cs44/preview](https://onlinecourses.nptel.ac.in/noc22_cs44/preview)
2. Udemy: <https://www.udemy.com/course/the-complete-nft-course-learn-everything-about-nfts/>
3. Udemy: <https://www.udemy.com/course/decentralized-finance>
4. arXiv: <https://arxiv.org/abs/2206.11821>
5. DeFi Learning <https://defi-learning.org/f22>

**Course Assessment:**

**ISE:**

- To be conducted in any of these forms - Assignment/ Quiz/ Presentation/ Class Test/ Case study etc. of 20 marks.
- ISE 20 Marks = 05 marks for attendance + 15 marks for activities.

**MSE:**

- To be conducted as written examination for 20 marks (on 40% - 50% syllabus).

**End Semester Examination:**

**\$ ESE of duration 03 hours are of 80 marks and scaled to 60.**

1. Question paper will comprise of 03 questions.
2. Question 1 (20 marks): - Solve any 04 out of 06. All questions carry 05 marks each.
3. Question 2 (40 marks): - Solve any 04 out of 06. All questions carry 10 marks each.
4. Question 3(20 marks):- Solve any 04 out of 06. All questions carry 05 marks each.
5. All COs should be mapped as per the weightage in the syllabus.

| Course Code        | Course Name                                             | Teaching Scheme (Hrs.) |           |           | Credits Assigned |           |           |           |
|--------------------|---------------------------------------------------------|------------------------|-----------|-----------|------------------|-----------|-----------|-----------|
|                    |                                                         | Theory                 | Practical | Tutorial  | Theory           | Practical | Tutorial  | Total     |
| <b>CSEPEC 6013</b> | <b>Vulnerability Assessment and Penetration Testing</b> | <b>03</b>              | <b>--</b> | <b>--</b> | <b>03</b>        | <b>--</b> | <b>--</b> | <b>03</b> |

| Course Code | Course Name                                      | Examination Scheme |     |                   |      |      |       |
|-------------|--------------------------------------------------|--------------------|-----|-------------------|------|------|-------|
|             |                                                  | Theory Marks       |     |                   | CIAP | ESEP | Total |
|             |                                                  | Course Assessment  |     | ESE <sup>\$</sup> |      |      |       |
|             |                                                  | ISE                | MSE |                   |      |      |       |
| CSEPEC 6013 | Vulnerability Assessment and Penetration Testing | 20                 | 20  | 60                | --   | --   | 100   |

**Pre-requisite:**

1. CSEC403: Computer Network
2. CSEC501: Cryptography and Network Security

**Program Outcomes addressed:**

1. PO1: Engineering Knowledge
2. PO2: Problem Analysis
3. PO3: Design/Development of Solutions
4. PO4: Conduct Investigations of Complex Problems
5. PO7: Ethics
6. PO11: Life-Long Learning

**Course Objectives:**

1. To gather security-related information using reconnaissance and vulnerability scanning tools.
2. To understand penetration testing concepts, methodologies, tools, and ethics.
3. To perform reconnaissance and scanning to identify system/network vulnerabilities.
4. To execute exploitation and post-exploitation using Metasploit and advanced payloads.
5. To identify and mitigate web application vulnerabilities using OWASP security principles.
6. To analyze recent trends in VAPT including cloud, IoT, automation, and continuous testing.

**Course Outcomes: Learners will be able to:**

1. Understand the basic principles for Information Gathering and Detecting Vulnerabilities in the system
2. Explain penetration testing methodologies, tools, and ethical/legal considerations in security assessments.
3. Apply various tools and techniques to find vulnerabilities in the system.
4. Execute system exploitation with Metasploit and advanced payload modules.
5. Analyze the impact of web application vulnerabilities.
6. Assess modern VAPT trends including cloud, IoT, automation, and continuous security testing.

| Module No. | Unit No.   | Topics                                                                                                                                                                                        | Hrs.      | CO         |
|------------|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|------------|
| <b>1.0</b> |            | <b>Information Gathering and Evading techniques</b>                                                                                                                                           | <b>07</b> |            |
|            | <b>1.1</b> | Information Gathering Techniques - Active, Passive and Sources of Information Gathering, Approaches and Tools - Traceroutes, Neotrace, Whatweb, Netcraft, Xcode Exploit Scanner and NSlookup, |           | <b>CO1</b> |
|            | <b>1.2</b> | Host discovery, Scanning for open ports and services ,Types of Port, Vulnerability Scanner Function, pros and cons and Vulnerability Assessment with NMAP                                     |           |            |
|            |            | <b>Self-Learning:</b> Social Media Intelligence (SOCMINT) for Information Gathering                                                                                                           |           |            |
| <b>2.0</b> |            | <b>Introduction to penetration testing</b>                                                                                                                                                    | <b>08</b> |            |
|            | <b>2.1</b> | Penetration testing concepts, Penetration testing methodology, Types of penetration testing, red/blue teaming, Tools and techniques used in penetration testing.                              |           | <b>CO2</b> |
|            | <b>2.2</b> | Testing methodologies (OSSTMM, PTES, and OWASP Testing Guide), and Rules of engagement, Vulnerability metrics (CVE, CWE, CVSS), Limitations of penetration testing tools                      |           |            |
|            |            | <b>Self-Learning:</b> Legal & Ethical Issues in Penetration Testing (Cyber Law, NDAs, Responsible Disclosure)                                                                                 |           |            |
| <b>3.0</b> |            | <b>Reconnaissance and scanning</b>                                                                                                                                                            | <b>06</b> |            |
|            | <b>3.1</b> | Introduction, types of reconnaissance, various techniques of recon (social engineering, web based recon, DNS based recon.                                                                     |           | <b>CO3</b> |
|            | <b>3.2</b> | Network based recon, Google hacking etc.), countermeasures, scanning, types of scanning (port scanning, network scanning, and vulnerability scanning), Sniffers.                              |           |            |
|            |            | <b>Self-Learning:</b> Footprinting using Social Media and OSINT Tools                                                                                                                         |           |            |
| <b>4.0</b> |            | <b>Exploits</b>                                                                                                                                                                               | <b>06</b> |            |
|            | <b>4.1</b> | Architecture and Environment, Leveraging Metasploit on Penetration Tests, Understanding Metasploit Channels, Metasploit Framework and Advanced Environment configurations.                    |           | <b>CO4</b> |
|            | <b>4.2</b> | Understanding the Soft Architecture, Configuration and Locking, Advanced payloads and addon modules Global data store, module data store, saved environment Meterpreter.                      |           |            |
|            |            | <b>Self-learning:</b> Evasion and Anti-Forensics Techniques in Metasploit.                                                                                                                    |           |            |
| <b>5.0</b> |            | <b>Web Application Security and vulnerabilities</b>                                                                                                                                           | <b>08</b> |            |
|            | <b>5.1</b> | Introduction to web applications security, threats and OWASP principles, OWASP top 10 web application vulnerabilities, introduction to secure design.                                         |           | <b>CO5</b> |
|            | <b>5.2</b> | Browser: general concepts, functionalities, browsers war,                                                                                                                                     |           |            |

|            |            |                                                                                                                                                                                                                                                                                 |           |            |
|------------|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|------------|
|            |            | configuration, and users tracking/profiling, browser security OWASP, Privacy preserving: attacks to privacy, Tracking techniques, Advanced browser configuration, anonymity and onion routing (Tor), phishing, spamming & spoofing, DKIM, SPF, introduction to email forensics. |           |            |
|            |            | <b>Self-Learning:</b> Web Application Firewall (WAF) Concepts and Bypass Techniques                                                                                                                                                                                             |           |            |
| <b>6.0</b> |            | <b>Recent Trends in VAPT Cloud-based VAPT</b>                                                                                                                                                                                                                                   | <b>04</b> |            |
|            | <b>6.1</b> | Cloud-based VAPT, IoT Security Testing, Automated Vulnerability Scanning, Compliance-driven Assessments, Continuous VAPT                                                                                                                                                        |           | <b>CO6</b> |
|            |            | <b>Self-Learning:</b> Threat Modeling for Cloud and IoT Ecosystems.                                                                                                                                                                                                             |           |            |
|            |            | <b>Total</b>                                                                                                                                                                                                                                                                    | <b>39</b> |            |

#### Textbooks:

1. P. Joshi and D. Chanda, Penetration Testing with Kali Linux: Learn Hands-on Penetration Testing Using a Process-Driven Framework. New Delhi, India: BPB Publications, 2021.
2. S. Oriyano and M. Solomon, Hacker Techniques, Tools, and Incident Handling, 3rd ed. Burlington, MA, USA: Jones & Bartlett Learning, 2020.
3. M. Walker, CEH Certified Ethical Hacker All-in-One Exam Guide, 5th ed. New York, NY, USA: McGraw-Hill Education, 2023.
4. C. Easttom, Penetration Testing Fundamentals: A Hands-On Guide to Reliable Security Audits. Upper Saddle River, NJ, USA: Pearson Education, 2018.

#### Reference books:

1. V. Ramachandran and C. Buchanan, Kali Linux Wireless Penetration Testing Beginner's Guide. Birmingham, U.K.: Packt Publishing, 2017.
2. J. Clarke-Salt, SQL Injection Attacks and Defense, 1st ed. Waltham, MA, USA: Syngress Publishing, 2019.
3. P. Prasad, Mastering Modern Web Penetration Testing. Birmingham, U.K.: Packt Publishing, Oct. 2016.
4. W. Halton and B. Weaver, Kali Linux 2: Windows Penetration Testing. Birmingham, U.K.: Packt Publishing, Jun. 2016.
5. G. Khawaja, Practical Web Penetration Testing: Secure Web Applications Using Burp Suite, Nmap, Metasploit, and More, 2<sup>nd</sup> ed. Birmingham, U.K.: Packt Publishing, 2021.

#### Online Resources:

1. NPTEL Course: [https://onlinecourses.nptel.ac.in/noc26\\_lw01/preview?utm\\_source](https://onlinecourses.nptel.ac.in/noc26_lw01/preview?utm_source)
2. NPTEL Course: [https://elearn.nptel.ac.in/shop/completed-courses/partnering-closed/learning-red-team-cybersecurity-with-ctf/?utm\\_source&v=13b5bfe96f3e](https://elearn.nptel.ac.in/shop/completed-courses/partnering-closed/learning-red-team-cybersecurity-with-ctf/?utm_source&v=13b5bfe96f3e)
3. Coursera Course : <https://www.coursera.org/professional-certificates/ibm-cybersecurity-analyst>
4. Coursera Course: <https://www.coursera.org/professional-certificates/google-cybersecurity>
5. OWASP Foundation: <https://owasp.org/>

**Course Assessment:**

**ISE:**

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- ISE 20 marks = 05 marks for attendance + 15 marks for activities.

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**End Semester Examination:**

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4. Question 3 (20 marks): - Solve any 04 out of 06. All questions carry 05 marks each.
5. All COs should be mapped as per the weightage in the syllabus.

| Course Code        | Course Name                             | Teaching Scheme (Hrs.) |           |          | Credits Assigned |           |          |           |
|--------------------|-----------------------------------------|------------------------|-----------|----------|------------------|-----------|----------|-----------|
|                    |                                         | Theory                 | Practical | Tutorial | Theory           | Practical | Tutorial | Total     |
| <b>CSEPEC 6014</b> | <b>Data Analytics and Visualization</b> | <b>03</b>              | <b>-</b>  | <b>-</b> | <b>03</b>        | <b>-</b>  | <b>-</b> | <b>03</b> |

| Course Code | Course Name                      | Examination Scheme |     |       |      |      |       |
|-------------|----------------------------------|--------------------|-----|-------|------|------|-------|
|             |                                  | Theory Marks       |     |       | CIAP | ESEP | Total |
|             |                                  | Course Assessment  |     | ESE\$ |      |      |       |
|             |                                  | ISE                | MSE |       |      |      |       |
| CSEPEC 6014 | Data Analytics and Visualization | 20                 | 20  | 60    | -    | -    | 100   |

**Pre- requisite:**

1. CSEC301: Applied Mathematics III
2. CSEC304: Database Management System
3. CSEL304: Python Programming

**Program Outcomes Addressed**

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO3: Design/Development of Solutions
4. PO9: Communication
5. PO11: Life-Long Learning

**Course Objectives:**

1. To introduce fundamental concepts of data analytics, its lifecycle, and the role of data in decision-making.
2. To explain regression methods and statistical modeling techniques for predictive analytics.
3. To enable application of time series forecasting methods on real-world and IoT datasets.
4. To analyze unstructured text data using text mining and sentiment analysis techniques.
5. To evaluate datasets using R for statistical analysis, visualization, and exploratory insights.
6. To design and build interactive dashboards using Power BI/Tableau for domain-specific and IoT-based analytics.

**Course Outcomes: Learners will be able to**

1. Explain the data analytics lifecycle and its key stages.
2. Describe and interpret regression models and their application scenarios.
3. Analyze time-series components and explain AR/MA/ARIMA forecasting methods.
4. Examine text analytics techniques for extracting insights from unstructured data.
5. Apply statistical and visualization concepts using R for exploratory data analysis.
6. Evaluate BI visualizations in Power BI and Tableau for analytical decision-making.

| Module No. | Unit No. | Topics                                                                                                                                                                                                                                                                                                                                                 | Hrs. | CO  |
|------------|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-----|
| 1.0        |          | <b>Introduction to Data Analytics and Life Cycle</b>                                                                                                                                                                                                                                                                                                   | 05   |     |
|            | 1.1      | Database Management System, Python Programming.<br><b>Data Analytics Lifecycle Overview:</b> Definition & Importance, Lifecycle Stages, Discovery Phase: Business Domain Understanding, Data Sources, Data Preparation: ETLT, Sandbox Setup, Data Conditioning, Model Planning and Model Building Tools, Communicating Results and Operationalization. |      | CO1 |
|            | 1.2      | <b>IoT Data Analytics Lifecycle:</b> Mapping IoT data through Discovery, Acquisition, Ingestion, ETLT Preparation, Model Building, and Operationalization (dashboards & alerts).                                                                                                                                                                       |      |     |
|            |          | <b>Self-learning Topics:</b> RFID-based Attendance System                                                                                                                                                                                                                                                                                              |      |     |
| 2.0        |          | <b>Regression Models</b>                                                                                                                                                                                                                                                                                                                               | 08   |     |
|            | 2.1      | <b>Simple Linear Regression:</b> Equation, Residuals, Least Squares, Multiple Linear Regression: Model Selection, Cross Validation, Logistic Regression and GLM: Logit, Prediction, Odds Ratios, Model Assessment and Interpretation.                                                                                                                  |      | CO2 |
|            | 2.2      | <b>IoT Regression:</b> Regression-based prediction & anomaly detection using IoT sensor data.                                                                                                                                                                                                                                                          |      |     |
|            |          | <b>Self-learning Topics:</b> Regression-based machine failure prediction.                                                                                                                                                                                                                                                                              |      |     |
| 3.0        |          | <b>Time Series</b>                                                                                                                                                                                                                                                                                                                                     | 07   |     |
|            | 3.1      | <b>Introduction to Time Series and Box-Jenkins Methodology:</b> Autocorrelation, AR, MA, ARMA and ARIMA Models, Building and Evaluating Forecasting Models, Reasons to Choose and Cautions.                                                                                                                                                            |      | CO3 |
|            | 3.2      | <b>IoT Time Series Forecasting:</b> Using AR/MA/ARIMA models on IoT sensor streams with basic smoothing and noise handling.                                                                                                                                                                                                                            |      |     |
|            |          | <b>Self-learning Topics:</b> ARIMA-based energy meter forecasting.                                                                                                                                                                                                                                                                                     |      |     |
| 4.0        |          | <b>Text Analytics</b>                                                                                                                                                                                                                                                                                                                                  | 07   |     |
|            | 4.1      | Text Mining Background, Applications and Use Cases, Extracting Meaning from Unstructured Text, TF-IDF, Topic Categorization, Sentiment Analysis.                                                                                                                                                                                                       |      | CO4 |
|            | 4.2      | IoT Log Error Detection using TF-IDF.                                                                                                                                                                                                                                                                                                                  |      |     |
|            |          | <b>Self-learning Topics:</b> IoT Sensor Failure Detection using Text Analytics                                                                                                                                                                                                                                                                         |      |     |

| 5.0 |     | Data Analytics and Visualization with R                                                                                                                                                                                                                                                      | 06        |     |
|-----|-----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|-----|
|     | 5.1 | <b>Introduction to R:</b> Data Import, Export, Attributes, Data Types, Descriptive Statistics and Exploratory Data Analysis, Visualization: Single and multi-variable plots, Data Exploration vs Presentation.                                                                               |           | CO5 |
|     | 5.2 | Visualizing IoT Sensor Data in R.                                                                                                                                                                                                                                                            |           |     |
|     |     | <b>Self-learning Topics:</b> Smart Home Sensor Data Visualization                                                                                                                                                                                                                            |           |     |
| 6.0 |     | Data Visualization and Dashboard Design                                                                                                                                                                                                                                                      | 06        |     |
|     | 6.1 | <b>Visualization for Analytical Communication:</b> Purpose of data visualization, visualization as a communication tool, mapping analytical questions to visual forms, perception, clarity, and accuracy, ethical use of visuals.                                                            |           | CO6 |
|     | 6.2 | <b>Principles of Visual Encoding and Dashboard Design:</b> Basic visual encoding techniques, representation of categorical, numerical, temporal, and spatial data, dimensions vs measures, discrete vs continuous data, selection of appropriate charts, basic layout and design principles. |           |     |
|     | 6.3 | <b>Visualization of Time-Oriented and IoT Data:</b> Visualization of time-based and high-velocity data, identification of trends and anomalies, real-time dashboards, alerts, and KPIs, basics of geospatial visualization.                                                                  |           |     |
|     |     | <b>Self-learning Topics:</b> Conceptual design of a vehicle tracking and monitoring dashboard.                                                                                                                                                                                               |           |     |
|     |     | <b>Total</b>                                                                                                                                                                                                                                                                                 | <b>39</b> |     |

#### Textbooks:

1. MC Education Services, *Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data*, 1st ed., Wiley, 2015.
2. Bharti Motwani, *Data Analytics Using Python*, 1st ed., Wiley India Pvt. Ltd., 2020.
3. P. Bruce, A. Bruce & P. Gedeck, *Practical Statistics for Data Scientists: 50+ Essential Concepts Using R and Python*, 2nd ed., O'Reilly Media, 2020.
4. G. Miner & T. Hill, *Practical Text Mining and Statistical Analysis for Non-Structured Text Data Applications*, 1st ed.
5. Claus O. Wilke, *Fundamentals of Data Visualization: Principles and Practice*, 1st ed., O'Reilly Media, 2019.

#### Reference books:

1. Wes McKinney, *Python for Data Analysis*, 3rd ed., O'Reilly Media, 2022.
2. Neha Singh Rajput & Sulabh Bhatt, *Visual Analytics Using Tableau: Structured Approach for Turning Raw Data to Powerful Insights*, 1st ed., BPB Publications, 2024.
3. M. S. Hariharan, *IoT Data Analytics Using Python*, 1st ed., BPB Publications, 2023.
4. Qusay F. Hassan, *Internet of Things A to Z: Technologies and Applications*, 1st ed., Wiley, 2018.

5. Steve Wexler, Jeffrey Shaffer & Andy Cotgreave, *The Big Book of Dashboards: Visualizing Your Data Using Real-World Business Scenarios*, 1st ed., Wiley, 2017.

**Online References:**

1. NPTEL Course: [https://onlinecourses.swayam2.ac.in/imb25\\_mg218/preview](https://onlinecourses.swayam2.ac.in/imb25_mg218/preview)
2. NPTEL Course: [https://onlinecourses.nptel.ac.in/noc19\\_ge20/preview](https://onlinecourses.nptel.ac.in/noc19_ge20/preview)

**Course Assessment:**

**ISE:**

- To be conducted in any of these forms - Assignment/ Quiz/ Presentation/ Class Test/ Case study etc. of 20 marks.
- ISE 20 marks = 05 marks for attendance + 15 marks for activities.

**MSE:**

- To be conducted as written examination for 20 marks (on 40% - 50% syllabus).

**End Semester Examination:**

**\$ ESE of duration 03 hours are of 80 marks and scaled to 60.**

1. Question paper will comprise of 03 questions.
2. Question1(20 marks): - Solve any 04 out of 06. All questions carry 05 marks each.
3. Question 2 (40 marks): - Solve any 04 out of 06. All questions carry 10 marks each.
4. Question3(20 marks): - Solve any 04 out of 06. All questions carry 05 marks each.
5. All COs should be mapped as per the weightage in the syllabus.

| Course Code | Course Name                        | Teaching Scheme (Hrs.) |           |          | Credits Assigned |           |          |       |
|-------------|------------------------------------|------------------------|-----------|----------|------------------|-----------|----------|-------|
|             |                                    | Theory                 | Practical | Tutorial | Theory           | Practical | Tutorial | Total |
| CSEL601     | IoT Architecture and Protocols Lab | --                     | 02        | --       | --               | 01        | --       | 01    |

| Course Code | Course Name                        | Examination Scheme |     |                   |      |      |       |
|-------------|------------------------------------|--------------------|-----|-------------------|------|------|-------|
|             |                                    | Theory Marks       |     |                   | CIAP | ESEP | Total |
|             |                                    | Course Assessment  |     | ESE <sup>\$</sup> |      |      |       |
|             |                                    | ISE                | MSE |                   |      |      |       |
| CSEL601     | IoT Architecture and Protocols Lab | --                 | --  | --                | 25   | --   | 25    |

**Pre-requisite:**

1. CSEL 304: Python programming
2. FEC 104: C programming language
3. CSED 403: Computer Networks

**Program Outcomes Addressed:**

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO3: Design and development
4. PO5: Engineering tool.
5. PO11: Lifelong Learning

**Lab Objectives:**

1. To develop basic programming skills through graphical programming
2. To Learn the working of Arduino/ESP8266/ESP32/Raspberry Pi processor
3. To Understand the Building Blocks of IoT
4. To apply hardware interfacing and debugging techniques
5. To design and develop android apps.

**Lab Outcomes:**

1. At the end of the course, students will be able to the algorithms for simple problems
2. Demonstrate various sensor interfacing using Visual Programming Language.
3. Analyze various Physical Components.
4. Demonstrate Wireless Control of Remote Devices.
5. Design and develop Mobile Application and Wi-Fi which can interact with Sensor.
6. Illustrate various protocols at network layer and application layer for IoT.

| <b>Suggested List of Experiments:</b> Students are required to complete at least 12 experiments. |                                                                                                                                                                                                                                                                                                                                                                 |           |
|--------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| <b>S.No.</b>                                                                                     | <b>Title of Experiments</b>                                                                                                                                                                                                                                                                                                                                     | <b>LO</b> |
| 1.                                                                                               | An embedded systems startup is onboarding interns who have no prior experience with microcontroller platforms. As a junior IoT engineer, design a basic setup workflow that enables beginners to configure the Arduino development environment, connect hardware correctly, and verify successful communication between software and board using test programs. | LO1       |
| 2.                                                                                               | In a smart office environment, visual and audio alerts are required to notify employees about periodic system events. Develop a microcontroller-based alert system that activates an LED and buzzer for a fixed duration at regular intervals to simulate timed notifications.                                                                                  | LO1       |
| 3.                                                                                               | In a smart residential complex, an entry point must be accessible via two methods: a manual override (push button) for authorized personnel and an automated detection system (PIR or IR sensor) for security monitoring.                                                                                                                                       | LO2       |
| 4.                                                                                               | A local clinic requires a bedside monitoring unit to display patient body temperature in real time. Develop a system using a temperature sensor and display module that continuously measures and displays temperature readings on an LCD for medical staff.                                                                                                    | LO3       |
| 5.                                                                                               | Farmers need real-time environmental data to protect crops inside greenhouses. Design an IoT node that senses temperature and humidity using appropriate sensors and displays the readings for monitoring greenhouse conditions.                                                                                                                                | LO3       |
| 6.                                                                                               | A research organization wants to collect weather data remotely for analysis. Develop an IoT solution that periodically uploads temperature and humidity sensor readings to a cloud platform, enabling long-term storage and visualization.                                                                                                                      | LO3       |
| 7.                                                                                               | In a small manufacturing unit, machines need to be started remotely for safety and efficiency. Design a relay-based motor control system that allows an operator to activate a motor using a push button, simulating industrial equipment control.                                                                                                              | LO4, LO5  |
| 8.                                                                                               | A fitness tracking application requires sensor data to be transferred wirelessly to a smartphone. Implement a Bluetooth-based embedded system that captures sensor readings and transmits them to a mobile device in real time.                                                                                                                                 | LO4       |
| 9.                                                                                               | An IoT solutions company plans to deploy Raspberry Pi as an edge gateway for data aggregation. As an engineer, prepare the Raspberry Pi platform by installing the necessary operating system and software tools to enable future IoT application development.                                                                                                  | LO5, LO6  |
| 10.                                                                                              | A smart home requires a status indicator to confirm system health. Design a Raspberry Pi-based control program that activates an LED or buzzer periodically to indicate that the home automation controller is functioning correctly.                                                                                                                           | LO6       |
| 11.                                                                                              | A smart parking system must detect vehicle presence in parking slots. Develop a Raspberry Pi-based solution using an ultrasonic                                                                                                                                                                                                                                 | LO2, LO3  |

|     |                                                                                                                                                                                                                                         |          |
|-----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
|     | sensor that detects nearby objects and controls an indicator to show parking availability.                                                                                                                                              |          |
| 12. | A monitoring dashboard needs to retrieve previously stored environmental data for decision-making. Create an application that fetches temperature and humidity readings from a cloud platform and displays them locally for analysis.   | LO1      |
| 13. | A smart city project requires real-time sensor data sharing across multiple services. Design an IoT publisher system that uses the MQTT protocol to transmit temperature data from a device to a broker for consumption by subscribers. | LO1      |
| 14. | An industrial monitoring setup requires a custom network service that responds to client requests. Implement a TCP server on an IoT device that sends sensor data upon request from an authorized client system.                        | LO2      |
| 15. | A homeowner wants to control electrical appliances remotely while traveling. Design an IoT-based solution that allows a user to control a device over the internet from anywhere in the world, ensuring reliability and basic security. | LO5, LO6 |

#### **Text & Reference Books:**

1. S. L. Martinez and G. S. Stager, *Invent to Learn: Making, Tinkering, and Engineering in the Classroom*. Constructing Modern Knowledge Press, 2016.
2. M. Margolis, *Arduino Cookbook*. O'Reilly, 2011.

#### **CIAP:**

- Term work shall include a total of 12 experiments. (Ensure that all the LOs are covered)
- Term work will be assessed as Continuous Internal Assessment Practical (CIAP).

#### **CIAP Marks Distribution:**

- 25 Marks (Total Marks) = 20 Marks (Experiment) + 05 Marks (Attendance)
- The final certification and acceptance of term work ensure satisfactory performance of laboratory work and minimum passing marks in term work.

| Course Code | Course Name                               | Teaching Scheme (Hrs.) |           |          | Credits Assigned |           |          |       |
|-------------|-------------------------------------------|------------------------|-----------|----------|------------------|-----------|----------|-------|
|             |                                           | Theory                 | Practical | Tutorial | Theory           | Practical | Tutorial | Total |
| CSEL602     | Digital Forensics and Ethical Hacking Lab | --                     | 02        | --       | --               | 01        | --       | 01    |

| Course Code | Course Name                               | Examination Scheme |     |                   |      |      |       |
|-------------|-------------------------------------------|--------------------|-----|-------------------|------|------|-------|
|             |                                           | Theory Marks       |     |                   | CIAP | ESEP | Total |
|             |                                           | Course Assessment  |     | ESE <sup>\$</sup> |      |      |       |
|             |                                           | ISE                | MSE |                   |      |      |       |
| CSEL602     | Digital Forensics and Ethical Hacking Lab | --                 | --  | --                | 25   | 25   | 50    |

**Prerequisite :**

1. CSEL403: Computer Networks Lab

**Program Outcomes addressed:**

1. PO1: Engineering Knowledge
2. PO2: Problem Analysis
3. PO4: Conduct Investigations of Complex Problems
4. PO5: Engineering Tool Usage
5. PO7: Ethics
6. PO11: Life-Long Learning

**Lab Objectives:**

1. To familiarize students with forensic acquisition techniques for both static and live data on Windows and Linux systems.
2. To enable learners to create, analyze, and interpret forensic duplicates using industry-standard forensic tools.
3. To develop skills in using reconnaissance, footprinting, and enumeration tools for information gathering.
4. To train students in network scanning, traffic analysis, and service enumeration using professional assessment tools.
5. To provide hands-on experience in identifying vulnerabilities, performing exploitation, and conducting penetration testing in controlled environments.
6. To enhance practical cybersecurity proficiency through CTF-based exercises and real-world attack–defense simulations.

**Lab Outcomes:**

Upon completion of the course, learners will be able to:

1. Demonstrate the ability to perform static and live data acquisition on Windows and Linux using tools like FTK Imager, dd, and dcfldd.
2. Create and analyze forensic images using Autopsy, Bulk Extractor, and other forensic analysis tools.
3. Apply reconnaissance and active/passive footprinting techniques using tools such as dig, whois, traceroute, and nslookup.
4. Conduct network scanning and traffic analysis using Nmap, Wireshark, and related tools to identify hosts, services, and vulnerabilities.
5. Perform basic exploitation and vulnerability assessment tasks using DVWA, Metasploit, and penetration testing methodologies.
6. Participate in and solve Capture-the-Flag (CTF) challenges demonstrating applied cybersecurity and problem-solving skills..

### **Suggested List of Experiments:**

(Students are required to complete at least 12 experiments. )

| <b>Sr. No.</b> | <b>Title of Experiments</b>                                                                                                                                                                                                                                                              | <b>LO</b> |
|----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| 1              | Static Data Acquisition (Windows OS): A corporate workstation suspected of hosting pirated software needs to be examined. Investigators must use FTK Imager to capture the system's hard drive image, ensuring the evidence is preserved with hash verification for court admissibility. | LO1       |
| 2              | Live Data Acquisition (Windows OS): A compromised Windows server is actively communicating with an unknown IP address. Investigators must use FTK Imager to capture volatile memory and TCP Dump to record live network traffic without disrupting critical services.                    | LO1       |
| 3              | Static Data Acquisition (Linux OS): A Linux-based web server suspected of hosting illegal content must be imaged. Investigators will use <b>dd</b> and <b>dcfldd</b> to create a forensic copy of the disk, ensuring integrity through hash validation.                                  | LO1       |
| 4              | Live Data Acquisition (Linux OS): Formulate a method to capture volatile and live forensic data from a Linux operating system using tools such as Kali Linux and fdisk, ensuring accuracy and minimal system disruption.                                                                 | LO1       |
| 5              | Investigators receive a forensic duplicate of a suspect's laptop. Using Autopsy and Bulk Extractor, they must extract emails, credit card numbers, and hidden files to identify incriminating evidence.                                                                                  | LO2       |
| 6              | Virtual Environment Setup & Reconnaissance: Establish a controlled environment by installing VirtualBox and Kali Linux, then configure reconnaissance tools (Dig, Whois, traceroute, ifconfig, etc.) to support systematic information gathering for security analysis.                  | LO3       |
| 7              | Active Footprinting & DNS Enumeration: Demonstrate techniques for active footprinting and DNS enumeration using DIG and NSLOOKUP tools, focusing on extracting domain-related intelligence for forensic and security investigations.                                                     | LO3       |
| 8              | Network Scanning with Nmap: A penetration tester uses Nmap to identify active hosts, open ports, and running services on a corporate subnet, preparing for deeper vulnerability assessment.                                                                                              | LO4       |
| 9              | Packet Analysis with Wireshark: Establish a method to capture and analyze network                                                                                                                                                                                                        | LO4       |

|    |                                                                                                                                                                                                                                                          |     |
|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
|    | traffic using Wireshark, focusing on identifying patterns, anomalies, and potential security threats within packet data.                                                                                                                                 |     |
| 10 | SQL Injection on DVWA: Demonstrate and evaluate SQL Injection attacks on the Damn Vulnerable Web Application (DVWA) to understand common web application vulnerabilities and explore mitigation strategies.                                              | LO5 |
| 11 | Penetration Testing & Exploitation: Develop a structured methodology to perform penetration testing and vulnerability exploitation using Metasploit on Kali Linux, focusing on identifying and validating system weaknesses in a controlled environment. | LO5 |
| 12 | Password Cracking & Authentication Analysis: Conduct password cracking and authentication analysis in a controlled environment using tools like John the Ripper and Hydra, evaluating system resilience against brute-force and dictionary attacks.      | LO5 |
| 13 | Web Application Vulnerability Assessment: Establish a process to assess vulnerabilities in a test web application using OWASP ZAP and Burp Suite, with emphasis on detecting and analysing common web security flaws.                                    | LO5 |
| 14 | Capture the Flag (CTF): Demonstrate practical cybersecurity skills by participating in Capture the Flag (CTF-I) events, solving security challenges that simulate real-world attack and defense scenarios.                                               | LO6 |
| 15 | Log Analysis & Incident Investigation: A suspected insider threat requires investigators to analyse Windows logs and Linux logs to trace unauthorized access attempts and correlate them with suspicious activities.                                     | LO6 |

#### **Textbooks:**

1. William Stallings and Lawrie Brown, Computer Security: Principles and Practice, 5th ed. Harlow, U.K.: Pearson, 2024.
2. Bill Nelson, Amelia Phillips, and Christopher Steuart, Guide to Computer Forensics and Investigations, 6th ed. Boston, MA, USA: Cengage Learning, 2022.
3. EC-Council, Certified Ethical Hacker (CEH) v11 Official Courseware. Albuquerque, NM, USA: EC-Council, 2021.
4. Georgia Weidman, Penetration Testing: A Hands-On Introduction to Hacking. San Francisco, CA, USA: No Starch Press, 2014.
5. Michael Gregg, Build Your Own Security Lab: A Field Guide for Network Testing, 1st ed. Indianapolis, IN, USA: Wiley, 2008.

#### **Reference books:**

1. Charles P. Pfleeger and Shari Lawrence Pfleeger, Security in Computing, 6th ed. Hoboken, NJ, USA: Pearson, 2023.
2. Kevin Beaver, Hacking For Dummies, 6th ed. Hoboken, NJ, USA: Wiley, 2023.
3. Chuck Easttom, Computer Security Fundamentals, 4th ed. Hoboken, NJ, USA: Pearson, 2022.
4. Justin Seitz, Black Hat Python: Python Programming for Hackers and Pentesters, 2nd ed. San Francisco, CA, USA: No Starch Press, 2021.
5. Peter Kim, The Hacker Playbook 3: Practical Guide to Penetration Testing. Charleston, SC, USA: Secure Planet, 2018.

### Online Resources

1. NPTEL Ethical Hacking Course : <http://www.opentechinfo.com/learn-use-kali-linux/>
2. Kali Linux Learning Tutorial : <https://owasp.org/www-project-top-ten/>
3. PentesterLab Practical Security Labs : <http://www.opentechinfo.com/learn-use-kali-linux/>
4. YouTube Ethical Hacking Video Playlist : <https://pentesterlab.com/>
5. OWASP Web Vulnerability Guide : <https://www.youtube.com/playlist?list=PLx2aAxxVN1NVk9JwAQwCNA159FrSXQ5Hn>

### Term Work:

- The term work shall include a total of 12 experiments (Ensure that all LO's are covered). The final certification and acceptance of term work ensure satisfactory performance at laboratory work and minimum passing marks in term work. Term work will be assessed as Continuous Internal Assessment Practical (CIAP).

### Term work Marks (CIAP):

- 25 Marks (Total Marks) = 20 Marks (Experiment) + 05 Marks (Attendance)
- The final certification and acceptance of term work ensure satisfactory performance of laboratory work and minimum passing marks in term work.

### Oral Exam (ESEP): (2 hours/ 25 Marks)

- End-semester oral exam will be held based on the above syllabus and will be conducted as End Semester Examination Practical (ESEP).

| Course Code | Course Name                            | Teaching Scheme (Hrs.) |           |          | Credits Assigned |           |          |       |
|-------------|----------------------------------------|------------------------|-----------|----------|------------------|-----------|----------|-------|
|             |                                        | Theory                 | Practical | Tutorial | Theory           | Practical | Tutorial | Total |
| CSEL603     | Cloud Computing and Cloud Security Lab | 02*                    | 02        | --       | --               | 02        | --       | 02    |

| Course Code | Course Name                            | Examination Scheme |     |                   |      |      |       |
|-------------|----------------------------------------|--------------------|-----|-------------------|------|------|-------|
|             |                                        | Theory Marks       |     |                   | CIAP | ESEP | Total |
|             |                                        | Course Assessment  |     | ESE <sup>\$</sup> |      |      |       |
|             |                                        | ISE                | MSE |                   |      |      |       |
| CSEL603     | Cloud Computing and Cloud Security Lab | --                 | --  | --                | 25   | 25   | 50    |

**Prerequisite :**

1. CSEC 402: Operating System
2. CSEC 403: Computer Network

**Program Outcomes addressed:**

1. PO1: Engineering knowledge.
2. PO2: Problem analysis.
3. PO3: Design/ Development of solution.
4. PO4 Conduct Investigations of Complex Problems.
5. PO5 : Modern Tool Usage
6. PO6 The Engineer and Society
7. PO12 Life-long Learning

**Lab Objectives:**

1. To Understand cloud concepts, architecture, and deployment models.
2. To Study virtualization concepts and explore types and techniques in virtualized environments.
3. To Analyze cloud storage systems, data center architectures, and SLAs.
4. To identify various security concerns, risks, and mitigation techniques in cloud computing.
5. To Explore recent trends, IoT integration, and modern cloud platforms.
6. To Examine cloud integration with Edge and Fog computing for real-world applications.

**Lab Outcomes: Learners will be able to**

1. Apply basic cloud-based applications.
2. Explain concepts of virtualization in cloud computing.
3. Manage cloud storage systems and services.
4. Implement security mechanisms in cloud computing environments.
5. Utilize various cloud platforms effectively.
6. Analyze cloud integration with Edge, Fog, and IoT for real-world use.

| Module No. | Unit No.   | Topics                                                                                                                                                                                             | Hrs.      | LO         |
|------------|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|------------|
| <b>1.0</b> |            | <b>Fundamentals of Cloud Computing</b>                                                                                                                                                             | <b>04</b> | <b>LO1</b> |
|            | <b>1.1</b> | Definition of Cloud Computing, Characteristics of Cloud computing, Cloud Deployment Models(Introduction, advantages and disadvantages): Public Cloud, Private Cloud, Community Cloud, Hybrid Cloud |           |            |
|            | <b>1.2</b> | Cloud Service Models (Function, advantages, disadvantages) : IaaS, PaaS, SaaS Cloud cost benefits                                                                                                  |           |            |
|            |            | <b>Self-Learning:</b> Introduction to Cloud Computing: Concepts, Models, and Benefits                                                                                                              |           |            |
| <b>2.0</b> |            | <b>Virtualization</b>                                                                                                                                                                              | <b>04</b> | <b>LO2</b> |
|            | <b>2.1</b> | Introduction, Virtualization Reference Model, Characteristics of virtualized environment Differentiate various types of Virtualization : Storage, Network , Desktop , Application server.          |           |            |
|            | <b>2.2</b> | Definition and Life Cycle of Virtual Machine(VM), VM Migration: Concept and Techniques, VM Consolidation: Concepts, VM Management: Concepts Advantages and Disadvantages of Virtualization         |           |            |
|            |            | <b>Self-Learning:</b> Virtualization and Virtual Machines in Cloud Computing                                                                                                                       |           |            |
| <b>3.0</b> |            | <b>Cloud Storage, Monitoring and Management</b>                                                                                                                                                    | <b>05</b> | <b>LO3</b> |
|            | <b>3.1</b> | Cloud Storage System Architecture , Virtualize Data Centre (VDC) Architecture, VDC Environment, Cloud File Systems: Google File System (GFS), Hadoop Distributed File System (HDFS)                |           |            |
|            | <b>3.2</b> | Service Level Agreement (SLA) SLA management: Phases of SLA management, Types of SLA: Infrastructure SLA and Application SLA, Life cycle of SLA                                                    |           |            |
|            |            | <b>Self-Learning:</b> Cloud Storage and Service Level Agreements (SLA)                                                                                                                             |           |            |
| <b>4.0</b> |            | <b>Security in Cloud Computing</b>                                                                                                                                                                 | <b>04</b> | <b>LO4</b> |
|            | <b>4.1</b> | Cloud Security Concepts: Multi-tenancy, Virtualization, Data Outsourcing and Trust Management, Metadata security                                                                                   |           |            |
|            | <b>4.2</b> | Cloud Risk: Concept, Types of Cloud Risks, Policy and Organizational Risks, Technical Risks, Legal Risks                                                                                           |           |            |
|            | <b>4.3</b> | Data security technologies, Data Security risks, Digital Identity and Access Management, Content level security: Pros and Cons, Features of Security-As-A-Cloud Service                            |           |            |
|            |            | <b>Self-Learning:</b> Cloud Security Concepts and Risk Management                                                                                                                                  |           |            |
| <b>5.0</b> |            | <b>Trends in Cloud</b>                                                                                                                                                                             | <b>05</b> | <b>LO5</b> |
|            | <b>5.1</b> | Cloud trends in supporting Ubiquitous Computing , Enabling Technology in the Internet of Things                                                                                                    |           |            |

|            |            |                                                                                                                                            |           |            |
|------------|------------|--------------------------------------------------------------------------------------------------------------------------------------------|-----------|------------|
|            | <b>5.2</b> | Innovative Applications with the Internet of Things, Benefits of Cloud Platforms                                                           |           |            |
|            |            | <b>Self-Learning:</b> Cloud Trends and IoT Integration                                                                                     |           |            |
| <b>6.0</b> |            | <b>Cloud Integration and Emerging Technologies</b>                                                                                         | <b>04</b> | <b>LO6</b> |
|            | <b>6.1</b> | Introduction to Edge and Fog Computing, Comparison: Cloud vs. Edge vs. Fog, Benefits and limitations of Edge and Fog in Cloud environments |           |            |
|            | <b>6.2</b> | Use cases: Smart cities, IoT, autonomous vehicles                                                                                          |           |            |
|            |            | <b>Self-Learning:</b> Edge and Fog Computing in Cloud Environments                                                                         |           |            |
|            |            | <b>Total</b>                                                                                                                               | <b>26</b> |            |

#### Textbooks:

1. Rajkumar Buyya, Christian Vecchiola, and S. Thamarai Selvi, Mastering Cloud Computing: Foundations and Applications Programming, 2nd ed. Cambridge, MA, USA: Morgan Kaufmann, 2023.
2. Thomas Erl, Zaigham Mahmood, and Ricardo Puttini, Cloud Computing: Concepts, Technology & Architecture. Hoboken, NJ, USA: Pearson, 2019.
3. Barrie Sosinsky, Cloud Computing Bible, 2nd ed. Hoboken, NJ, USA: Wiley, 2020.
4. Kai Hwang, Geoffrey C. Fox, and Jack J. Dongarra, Distributed and Cloud Computing: From Parallel Processing to the Internet of Things. Cambridge, MA, USA: Morgan Kaufmann, 2012.

#### Reference books:

1. Michael J. Kavis, Architecting the Cloud: Design Decisions for Cloud Computing Service Models (SaaS, PaaS, and IaaS), 2nd ed. Hoboken, NJ, USA: Wiley, 2021.
2. Kumar Saurabh, Cloud Computing Insights into New-Era Infrastructure, 2nd ed. Hoboken, NJ, USA: Wiley, 2021.
3. Shantanu Pal, Cloud Computing: Principles and Paradigms. New Delhi, India: Wiley India, 2018.
4. Dan C. Marinescu, Cloud Computing: Theory and Practice, 2nd ed. Cambridge, MA, USA: Morgan Kaufmann, 2017.
5. Arshdeep Bahga and Vijay Madisetti, Internet of Things: A Hands-On Approach. Hyderabad, India: Universities Press, 2015.

### Online Resources

1. Cloud computing overview: <https://www.techopedia.com/definition/2/cloud-computing>
2. NPTEL Cloud Computing Course : <https://nptel.ac.in/courses/106105167>
3. Service Level Agreements: <https://www.geeksforgeeks.org/service-level-agreements-in-cloud-computing/?ref=lbp>
4. Virtualization: <https://www.javatpoint.com/virtualization-in-cloud-computing>
5. Cloud Security on AWS : <https://www.coursera.org/learn/cloud-security-on-aws/supplement/AcCam/course-overview>
6. Research Paper:  
<https://www.proquest.com/openview/53e8a5ed4ebc5ff06d57eb9c9ba2a72/1?pq-origsite=gscholar&cbl=5444811>

**Suggested List of Experiments:** Students are required to complete at least 12 experiments.

| Sr. No. | Title of Experiments                                                                                                                                                                                                                                                                                                                  | LO       |
|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| 1       | Cloud Computing Fundamentals: Examine the basic characteristics, service models, and deployment models of cloud computing to understand its core architecture and applications.                                                                                                                                                       | LO1      |
| 2       | Students are required to create and manage a virtual machine using a cloud or virtualization platform. They must document the complete lifecycle: creation, execution, suspension, snapshotting, and deletion, with screenshots/logs. Reflection should include how lifecycle operations affect resource utilization and reliability. | LO1      |
| 3       | Platform as a Service (PaaS): Implement and evaluate PaaS solutions using AWS Elastic Beanstalk or Microsoft Azure App Service to deploy and manage applications.                                                                                                                                                                     | LO2      |
| 4       | Students must provision and configure virtualized computing resources (VMs, networking, storage) using AWS EC2 or Azure Virtual Machines. They will analyze resource allocation, cost efficiency, and management overhead compared to on-premises infrastructure                                                                      | LO2      |
| 5       | Storage as a Service (STaaS): Drive cloud-based storage solutions using OwnCloud, AWS S3/Glacier, or Azure Storage to evaluate scalability and reliability.                                                                                                                                                                           | LO2      |
| 6       | Cloud-hosted Web Application: Design and deploy a web application on a public cloud platform integrating IaaS, PaaS, DBaaS, STaaS, and SECaaS concepts.                                                                                                                                                                               | LO2, LO3 |
| 7       | Students must implement a serverless function using AWS Lambda or Azure Functions. Design an event-driven workflow (e.g., image upload triggering a resize function) and analyze how serverless computing eliminates infrastructure management while ensuring scalability.                                                            | LO3      |
| 8       | Security as a Service (SECaaS): Implement cloud-based security services on AWS or Azure to evaluate protection mechanisms and compliance.                                                                                                                                                                                             | LO2      |
| 9       | Identity and Access Management (IAM): Study and implement IAM practices on AWS/Azure to ensure secure authentication and authorization in cloud                                                                                                                                                                                       | LO4      |

|    |                                                                                                                                                                                                                                                                                           |     |
|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
|    | environments.                                                                                                                                                                                                                                                                             |     |
| 10 | Cloud Monitoring & Logging: Set up AWS CloudWatch or Azure Monitor to collect metrics, visualize dashboards, and configure alerts for resource usage in a sample cloud application.                                                                                                       | LO4 |
| 11 | Database as a Service (DBaaS): Deploy and analyze SQL/NoSQL databases using AWS RDS, Azure SQL, MongoDB Lab, or Firebase to understand managed database services.                                                                                                                         | LO5 |
| 12 | Cloud Backup & Disaster Recovery: Study and implement cloud backup, disaster recovery, and high availability strategies using multi-region deployment and snapshots.                                                                                                                      | LO5 |
| 13 | Students must implement containerization using Docker to package and deploy a lightweight application. They will evaluate portability by running the container across different environments and document how containerization reduces overhead compared to traditional virtual machines. | LO6 |
| 14 | Container Orchestration: Study and implement Kubernetes for container orchestration to manage scalability, availability, and automation of containerized applications.                                                                                                                    | LO6 |
| 15 | DevOps on Cloud: Build a CI/CD pipeline using AWS CodePipeline, Azure DevOps, or GitHub Actions to automate code build, test, and deployment for a demo project.                                                                                                                          | LO6 |

**Term Work:**

- The term work shall include a total of 12 experiments (Ensure that all LO's are covered). The final certification and acceptance of term work ensure satisfactory performance at laboratory work and minimum passing marks in term work. Term work will be assessed as Continuous Internal Assessment Practical (CIAP).

**Term work Marks (CIAP):**

- 25 Marks (Total Marks) = 20 Marks (Experiment) + 05 Marks (Attendance)
- The final certification and acceptance of term work ensure satisfactory performance of laboratory work and minimum passing marks in term work.

**Oral Exam (ESEP): (2 hours/ 25 Marks)**

- End-semester oral exam will be held based on the above syllabus and will be conducted as End Semester Examination Practical (ESEP).

| Course Code | Course Name                     | Teaching Scheme (Hrs.) |           |          | Credits Assigned |           |          |       |
|-------------|---------------------------------|------------------------|-----------|----------|------------------|-----------|----------|-------|
|             |                                 | Theory                 | Practical | Tutorial | Theory           | Practical | Tutorial | Total |
| MDML6012    | Natural Language Processing Lab | --                     | 02        | --       | --               | 01        | -        | 01    |

| Course Code | Course Name                     | Examination Scheme |     |     |      |      |       |
|-------------|---------------------------------|--------------------|-----|-----|------|------|-------|
|             |                                 | Theory Marks       |     |     | CIAP | ESEP | Total |
|             |                                 | Course Assessment  |     | ESE |      |      |       |
|             |                                 | ISE                | MSE |     |      |      |       |
| MDML6012    | Natural Language Processing Lab | --                 | --  | --  | 25   | --   | 25    |

**Pre- requisite:**

1. CEL304: Skill Lab(Python Programming)

**Program Outcomes Addressed**

1. PO1: Engineering Knowledge
2. PO2: Problem Analysis
3. PO3: Design/Development of Solutions
4. PO4: Conduct Investigations of Complex Problems
5. PO5: Engineering Tool Usage
6. PO11: Life-Long Learning

**Lab Objectives:**

1. To understand text preprocessing techniques for real-world NLP tasks.
2. To familiarize with linguistic analysis through morphology, N-grams, and chunking.
3. To build statistical analysis for N-grams and parsing.
4. To understand semantic analysis and document similarity techniques
5. To learn NLP systems using standard classification techniques.
6. To understand large language models for understanding architectural variations.

**Lab Outcomes:**

**Upon completion of this course, Learners will be able to:**

1. Apply various text processing techniques for real-world NLP tasks..
2. Analyze linguistic structures using morphological processing, N- grams, and chunking techniques.
3. Develop statistical and neural language models such as POS tagging, HMMs, and Pasers.
4. Use TF-IDF and cosine similarity to extract semantics and document distances
5. Analyze the performance of modern NLP models including NER, and BERT classification.
6. Compare outputs and capabilities of modern large language models to understand architectural differences.

**Suggested List of Experiments:** Students are required to complete at least 12 experiments.

| Sr. No. | Title of Experiments                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | LO  |
|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| 1       | <p>Basic Text Preprocessing Techniques</p> <p><b>Task:</b> You are given raw, unstructured text data and need to clean and prepare it for analysis. Using Python in Jupyter Notebook with NLTK, spaCy, and regex, you will apply basic preprocessing techniques like tokenization, filtering, script validation, stopword removal, stemming, and lemmatization. The aim is to convert noisy text into meaningful and structured tokens for further processing.</p> <p><b>Tools:</b> Python, Jupyter Notebook, NLTK, spaCy, regex..</p> | LO1 |
| 2       | <p>Perform morphological analysis on input text to extract root words and morphemes, and generate new word forms using inflectional and derivational rules. Input is raw text and output is root forms, morphemes, and generated word variants. Use stemming (e.g., Porter Stemmer in NLTK) for fast root extraction, or lemmatization (spaCy) for accurate dictionary forms.</p> <p><b>Tools:</b> Python, Jupyter Notebook, NLTK, spaCy, morphological analyzers.</p>                                                                 | LO2 |
| 3       | <p>Extraction of Email Addresses and Indian Mobile Numbers Using Regular Expressions</p> <p><b>Task:</b> Write a Python program using Regular Expressions to identify and extract all valid email addresses and Indian mobile numbers from an unstructured text document containing mixed information such as names, dates, and random numbers.</p> <p><b>Tools:</b> Python, Jupyter Notebook or any Python IDE, re (Regular Expressions) module.</p>                                                                                  | LO2 |
| 4       | <p>Implementation of N-Gram Language Model</p> <p><b>Tasks:</b> You are developing a simple language model to understand how words appear in sequence within a text. Using a given dataset, you will generate unigrams, bigrams, and trigrams, and calculate their probabilities. This helps in predicting the next word and understanding basic language patterns.</p> <p><b>Tools:</b> Python, Jupyter Notebook, NLTK, NumPy.</p>                                                                                                    | LO2 |
| 5       | <p>Evaluation of N-Gram Models Using Laplace and Good-Turing Smoothing</p> <p><b>Tasks:</b> Apply Laplace and Good-Turing smoothing techniques to N-gram language models and evaluate their impact on text prediction accuracy using appropriate metrics.</p> <p><b>Tools:</b> Python, Jupyter Notebook, NLTK, NumPy.</p>                                                                                                                                                                                                              | LO2 |
| 6       | <p>Perform chunking (shallow parsing) on text to extract phrases like noun phrases (NP) and verb phrases (VP)</p> <p><b>Tasks:</b> Perform chunking on the given text input to identify and extract syntactic phrases such as noun phrases and verb phrases. Example: "The quick brown fox jumps" → [NP: <i>The quick brown fox</i>] [VP: <i>jumps</i>]</p> <p><b>Tools:</b> Python, Jupyter Notebook, NLTK, spaCy.</p>                                                                                                                | LO3 |
| 7       | <p>Study of Part-of-Speech Taggers and POS Tagging</p> <p><b>Tasks:</b> Study different types of POS taggers (rule-based, statistical) and</p>                                                                                                                                                                                                                                                                                                                                                                                         | LO3 |

|    |                                                                                                                                                                                                                                                                                                                                                                                                                 |     |
|----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
|    | perform Part-of-Speech tagging on given text. Implement a simple rule-based POS tagger by hardcoding at least 5 grammar rules (e.g., words ending with “-ing” → Verb, “-ly” → Adverb, “-ness” → Noun, capitalized words → Proper Noun, determiners like “the/a” → Determiner) and apply them along with NLTK/spaCy tagging.<br><b>Tools:</b> Python, Jupyter Notebook, NLTK, spaCy.                             |     |
| 8  | Demonstration of Viterbi Algorithm for HMM-Based POS Tagging<br><b>Tasks:</b> Demonstrate the Viterbi algorithm for HMM-based POS tagging by first computing transition and emission probability tables from a given dataset, and then using them to find the most probable tag sequence for a sentence.<br><b>Tools:</b> Python, Jupyter Notebook, NumPy, NLTK.                                                | LO3 |
| 9  | Word Sense Disambiguation Using Lesk Algorithm<br><b>Task:</b> Select a sentence containing an ambiguous target word (e.g., bank). Retrieve all possible senses of the word using WordNet and extract their definitions. Compare the context words of the sentence with each sense’s gloss to compute overlap. Choose the sense with the maximum overlap as the correct meaning.<br><b>Tools:</b> Python, NLTK. | LO4 |
| 10 | Word Embeddings Using Word2Vec and GloVe<br><b>Tasks:</b> Generate word embeddings using CBOW and Skip-gram (Word2Vec) and GloVe, and visualize them using dimensionality reduction (e.g., PCA/t-SNE).<br>Analyze semantic relationships by checking similarity between words (e.g., king – man + woman ≈ queen) and observe clustering of related words.<br><b>Tools:</b> Python, Gensim, NumPy                | LO4 |
| 11 | TF-IDF and Document Similarity Analysis<br><b>Tasks:</b> Convert text documents into numerical vectors using TF-IDF by calculating term frequency (TF), inverse document frequency (IDF), and TF-IDF scores.<br>Compute similarity between documents using measures like cosine similarity to identify how closely related the documents are.<br><b>Tools:</b> Python, scikit-learn, NumPy                      | LO4 |
| 12 | Study of Transformer Architecture and Self-Attention Mechanism<br><b>Task:</b> Study Large Language Models (LLMs) and explore the core components of the Transformer model, including self-attention, positional encoding, and encoder-decoder architecture using sample text data.<br><b>Tools:</b> Python, Jupyter Notebook, NumPy, PyTorch/TensorFlow, HuggingFace Transformers.                             | LO5 |
| 13 | Text Classification Using BERT Fine-Tuning<br><b>Tasks:</b> Fine-tune a pretrained BERT model on a labeled text dataset to perform text classification and evaluate its performance using appropriate metrics.<br><b>Tools:</b> Python, Jupyter Notebook, HuggingFace Transformers, PyTorch/TensorFlow, scikit-learn, datasets library.                                                                         | LO5 |
| 14 | Named Entity Recognition (NER) on Text Data                                                                                                                                                                                                                                                                                                                                                                     | LO6 |

|    |                                                                                                                                                                                                                                                                                                                                                                         |     |
|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
|    | <p><b>Tasks:</b> Implement NER to identify and classify entities such as person names, locations, organizations, dates, and numerical values from input text. Apply pretrained models (NLTK/spaCy) on a sample dataset and analyze the extracted entities.</p> <p><b>Tools:</b> Python, Jupyter Notebook, NLTK or spaCy, pretrained NER models, sample text dataset</p> |     |
| 15 | <p>Exploration of Modern NLP Models (GPT-4, Llama-3, Claude-3, Mistral, Gemini)</p> <p><b>Task:</b> Compare outputs of modern LLMs on the same text prompt and analyze differences in responses without coding complex models.</p> <p><b>Tools:</b> Web access to LLM APIs or interfaces, Python/Jupyter Notebook (optional for logging results).</p>                   | LO6 |

### Textbooks:

1. Joseph Babcock, Raghav Bali, "Generative AI with Python and TensorFlow", Packt Publishing, 2021.
2. Daniel Jurafsky, James H. and Martin, Speech and Language Processing, Third Edition, Prentice Hall, 2026.
3. Christopher D. Manning and Hinrich Schütze, Foundations of Statistical Natural Language Processing, MIT Press, 1999.
4. Pushpak Bhattacharyya and Aditya Joshi, Natural Language Processing, Wiley India Pvt. Ltd., Edition: 2023.
5. Dr. Tanmoy Chakraborty, "Introduction to Large Language Models: Generative AI for Text", Wiley (Wiley India). December 2024.

### Reference books:

1. Daniel M Bikel and Imed Zitouni — Multilingual natural language processing applications: from theory to practice, IBM Press, 2013.
2. Palash Goyal, Sumit Pandey, Karan Jain. *Deep Learning for Natural Language Processing*-2018

### Online Resources:

- Virtual lab: <https://nlp-iiith.vlabs.ac.in/List%20of%20experiments.html>
- Stanford CS224N <https://web.stanford.edu/class/cs224n/>
- NLTK <https://www.nltk.org/>
- spaCy <https://spacy.io/>
- Kaggle <https://www.kaggle.com/>

### Term Work:

Term work shall consist of at least 12 experiments (Ensure that all the LOs are covered.)

The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Term work will be assessed as Continuous Internal Assessment Practical (CIAP).

### Term work Marks:

- 25 Marks (Total Marks) = 20 Marks (Experiment) + 05 Marks (Attendance)
- The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.

| Course Code | Course Name                                      | Teaching Scheme (Hrs.) |           |          | Credits Assigned |           |          |       |
|-------------|--------------------------------------------------|------------------------|-----------|----------|------------------|-----------|----------|-------|
|             |                                                  | Theory                 | Practical | Tutorial | Theory           | Practical | Tutorial | Total |
| MDML6052    | System Programming and compiler Construction Lab | --                     | 02        | --       | --               | 01        | -        | 01    |

| Course Code | Course Name                                      | Examination Scheme |     |     |      |      |       |
|-------------|--------------------------------------------------|--------------------|-----|-----|------|------|-------|
|             |                                                  | Theory Marks       |     |     | CIAP | ESEP | Total |
|             |                                                  | Course Assessment  |     | ESE |      |      |       |
|             |                                                  | ISE                | MSE |     |      |      |       |
| MDML6052    | System Programming and compiler Construction Lab | --                 | --  | --  | 25   | --   | 25    |

**Pre- requisite:**

1. Automata Theory/ Discrete Structure and Automata Theory
2. Operating System.
3. Computer Organization and Architecture

**Program Outcomes Addressed**

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO3: Design/Development of solutions
4. PO6: The Engineer and The World
5. PO7: Ethics
6. PO11: Life-Long Learning

**Lab Objectives:**

1. To generate machine code by implementing two pass assemblers.
2. To implement Two pass macro processor.
3. To construct Top- down/Bottom-up parser.
4. To identify and Validate tokens for given high level language
5. To implement synthesis phase of compiler.
6. To explore LEX & YACC tools

**Lab Outcomes:**

**Upon completion of this course, learners will be able to:**

1. Identify data structures for implementation of two pass assemblers.
2. Design Two pass macro processor.
3. Use Lex and YACC tool for Compiler design
4. Construct various types of Parsers
5. Appreciate role of Intermediate Code Generation in connection with language designing
6. Apply optimization principles on given code

**Suggested List of Experiments:** Students are required to complete at least 12 experiments.

| Sr. No. | Title of Experiments                                                                                                                                                                                                                            | LO  |
|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| 1       | A startup building an embedded system needs to convert human-readable assembly instructions into machine code for a custom processor. Design a <b>two-pass assembler</b> that first builds symbol tables and then generates final machine code. | LO1 |
| 2       | A compiler toolchain company wants to support reusable code blocks in assembly using macros. Develop a two-pass macro processor that expands macros efficiently before actual assembly translation                                              | LO2 |
| 3       | A software company is developing a compiler for a new programming language. Implement a Lex-based lexical analyzer to scan source code and identify tokens such as keywords, operators, and identifiers.                                        | LO3 |
| 4       | A code analysis tool needs to break down C programs into meaningful components for further processing. Build a tokenizer in C that extracts tokens like keywords, literals, and symbols from source code.                                       | LO4 |
| 5       | An IDE wants to provide syntax highlighting by distinguishing reserved words from user-defined names. Write a Lex program that classifies tokens as keywords or identifiers in C programs.                                                      | LO3 |
| 6       | A compiler designer needs to validate grammar rules before parser construction. Develop a C program to compute FIRST and FOLLOW sets for a given grammar to assist in syntax analysis.                                                          | LO4 |
| 7       | A language processing system requires efficient syntax validation of code. Design and implement an SLR(1) bottom-up parser to parse input strings based on grammar rules using C program.                                                       | LO4 |
| 8       | A compiler development team is automating syntax checking of programs. Implement a YACC-based syntax analyzer that verifies whether input code follows defined grammar rules.                                                                   | LO3 |
| 9       | An educational compiler tool needs fast parsing for simple grammars. Write a predictive parser in C that uses LL(1) parsing techniques for syntax validation                                                                                    | LO4 |
| 10      | A static code analysis tool must identify operators used in programs for optimization. Create a LEX program to detect and classify different operators in C code.                                                                               | LO3 |
| 11      | A parser generator fails when given left-recursive grammars. Develop a C                                                                                                                                                                        | LO4 |

|    |                                                                                                                                                                                                    |     |
|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
|    | program to automatically eliminate left recursion from grammar rules to make them suitable for top-down parsing.                                                                                   |     |
| 12 | A compiler backend needs an intermediate representation for optimization. Write a C program that converts expressions into three-address code (TAC).                                               | LO5 |
| 13 | A software system aims to improve execution efficiency of compiled programs. Implement optimization techniques like constant folding, dead code elimination, and common subexpression elimination. | LO6 |
| 14 | A compiler must translate optimized intermediate code into machine-level instructions. Develop a target code generator that converts intermediate representation into assembly/machine code.       | LO5 |
| 15 | A data analytics company needs faster processing of large datasets. Implement a parallel sorting algorithm using OpenMP to improve performance on multi-core processors.                           | LO6 |

### Textbooks:

1. J. P. Bennett Introduction to Compiling Techniques A first course using ANSI C, Lex and Yacc, ISBN 0-07-053073-4, TMH
2. Charles N. Fischer, Richard J. LeBlanc Crafting a compiler with C, Pearson Education 2007

### Reference books:

1. John R levine ,”flex & bison”, ISBN 81-8404-816-5, SPD- O’Reilly
2. Anthony AabyCompiler “Construction using Flex and Bison”  
<http://cs.wvc.edu/~aabyan/464/Book>.
3. Andrew W. Appel Princeton University. Jens Palsberg Modern Compiler. Implementation in Java, Second Edition. Purdue University. CAMBRIDGE University press @2002.

### Online Resources:

1. IITK Tutorial: <https://cse.iitkgp.ac.in/~bivasm/notes/LexAndYaccTutorial.pdf>
2. IBM Tutorial: <https://www.ibm.com/docs/en/zos/2.1.0?topic=tools-tutorial-using-lex-yacc>

### Software Tools

#### 1. Lex and YACC tool

### Term Work:

- Term work should consist of at least 12 experiments.(Ensure that all LO’s are covered)

The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Term work will be assessed as Continuous Internal Assessment Practical (CIAP).

### Term work Marks (CIAP):

- 25 Marks (Total Marks) =20 Marks (Experiment) + 05 Marks (Attendance)
- The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.

| Course Code | Course Name        | Teaching Scheme (Hrs.) |           |          | Credits Assigned |           |          |       |
|-------------|--------------------|------------------------|-----------|----------|------------------|-----------|----------|-------|
|             |                    | Theory                 | Practical | Tutorial | Theory           | Practical | Tutorial | Total |
| CSEPEL6011  | Industrial IoT Lab | -                      | 02        | -        | --               | 01        | -        | 01    |

| Course Code | Course Name        | Examination Scheme |     |                  |      |      |       |
|-------------|--------------------|--------------------|-----|------------------|------|------|-------|
|             |                    | Theory Marks       |     |                  | CIAP | ESEP | Total |
|             |                    | Course Assessment  |     | ESE <sup>s</sup> |      |      |       |
|             |                    | ISE                | MSE |                  |      |      |       |
| CSEPEL 6011 | Industrial IoT Lab | --                 | --  | --               | 25   | --   | 25    |

**Pre-requisite:**

1. CSEL304 - Skill Lab - Python Programming
2. CSEC 601 - IoT Architecture and Protocols

**Program Outcomes addressed:**

1. PO1: Engineering knowledge.
2. PO2: Problem Analysis
3. PO3: Design/Development of Solutions
4. PO5: Engineering Tool Usage
5. PO8: Individual and Team Work
6. PO9: Communication
7. PO11: Life-long Learning

**Lab Objectives:**

1. To understand basic IoT and IIoT concepts using cloud simulation tools.
2. To practice MQTT communication and cloud data publishing using Python.
3. To visualize real-time IoT data using dashboards like ThingSpeak or Node-RED.
4. To simulate industrial protocols such as Modbus and REST APIs.
5. To implement basic edge processing and device communication using Python.
6. To analyze IIoT datasets and compare cloud vs. edge performance.

**Lab Outcomes: Upon completion of the course, learners will be able to**

- 1: Explain IIoT architecture, protocols, and cloud workflow.
- 2: Simulate MQTT, Modbus, and REST API communication using IoT tools.
- 3: Visualize real-time sensor data using cloud dashboards and Node-RED.
- 4: Develop IoT communication systems and edge applications using Python.
- 5: Create IoT automation flows and analyze sensor data for IIoT applications.
- 6: Evaluate edge vs cloud performance and IoT system efficiency.



| <b>Suggested List of Experiments: Students are required to complete 12 experiments</b> |                                                                                                                                                                                                                                                      | <b>LO</b> |
|----------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| <b>Sr. No.</b>                                                                         | <b>Title of Experiments</b>                                                                                                                                                                                                                          |           |
| 1.                                                                                     | A student designs and simulates a simple cloud-based IoT system to monitor industrial parameters like temperature or humidity, display data on a dashboard, and trigger basic alerts or actions based on predefined conditions in a lab environment. | LO1       |
| 2.                                                                                     | A user wants to understand lightweight communication in IoT systems. Implement MQTT architecture by creating a publisher and subscriber using Python to exchange messages through a broker and observe real-time data communication.                 | LO2       |
| 3.                                                                                     | An engineer needs to establish cloud connectivity for an IoT system. Develop a solution to publish simulated sensor data to a public MQTT broker and monitor the data transmission in real time..                                                    | LO2       |
| 4.                                                                                     | A technician needs to monitor sensor data in real time for better decision-making. Demonstrate real-time data visualization by sending data to a cloud dashboard using ThingSpeak or Node-RED and display it using graphs or charts.                 | LO3       |
| 5.                                                                                     | A developer implements and simulates the Modbus protocol using Python and a Modbus simulator in a lab environment to perform basic read and write operations between master and slave devices for understanding industrial communication.            | LO4       |
| 6.                                                                                     | A user creates a simple Node-RED automation flow and deploys a dashboard interface to monitor and control data, enabling basic visualization and interaction within an IoT-based system in environment.                                              | LO3       |
| 7.                                                                                     | A developer implements Python-based edge preprocessing by applying basic filtering techniques to sensor data in a lab environment for efficient data handling before cloud transmission.                                                             | LO5       |
| 8.                                                                                     | A user builds a simple REST API using Python Flask to enable IoT data exchange between devices and server, supporting basic data creation and retrieval operations in a lab setup.                                                                   | LO4       |
| 9.                                                                                     | A developer simulates device-to-device communication using Python socket programming in a lab environment to demonstrate basic data exchange between two connected systems over a network.                                                           | LO4       |
| 10.                                                                                    | A developer analyzes sensor anomalies using threshold-based fault detection in Python in a lab environment to identify abnormal sensor behavior in industrial IoT systems.                                                                           | LO5       |
| 11.                                                                                    | A user generates synthetic industrial sensor datasets using Python for testing IIoT applications and validating data processing techniques in a lab setup.                                                                                           | LO5       |
| 12.                                                                                    | A developer evaluates the performance of cloud and edge processing using sample datasets in a lab environment to compare processing efficiency and response time.                                                                                    | LO6       |
| 13                                                                                     | A developer evaluates MQTT message delivery using different Quality of Service (QoS) levels in an IIoT setup to understand reliability and communication performance..                                                                               | LO6       |
| 14                                                                                     | A user analyzes the effect of edge-based data filtering versus direct cloud transmission in an IIoT application to study bandwidth usage and data efficiency in a lab environment.                                                                   | LO6       |
| 15                                                                                     | A developer assesses real-time IoT data visualization performance using Node-RED dashboards in a lab environment to study responsiveness and display efficiency.                                                                                     | LO6       |

**Textbooks:**

1. Giancarlo Fortino and Paolo Trunfio, *Internet of Things Based on Smart Objects: Technology, Middleware and Applications*, 2nd ed., Cham, Switzerland: Springer, 2023.
2. Rajkumar Buyya and Amir Vahid Dastjerdi, *Internet of Things: Principles and Paradigms*, 2nd ed., Cambridge, MA, USA: Elsevier, 2021.
3. David Hanes *et al.*, *IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things*, 2nd ed., Indianapolis, IN, USA: Cisco Press, 2023.
4. Sudeep Tanwar, *Blockchain for IoT Systems: Security and Privacy Paradigms*, Amsterdam, Netherlands: Elsevier, 2022.

**Reference books:**

1. P. Rai, *Industrial Automation and IoT Applications*. New Delhi, India: McGraw Hill, 2023.
2. Arshdeep Bahga and Vijay Madisetti, *Internet of Things: A Hands-On Approach*, 2nd ed., Hyderabad, India: Universities Press, 2022.
3. Saurabh Kumar, *Industrial Internet of Things (IIoT): Applications, Security and Privacy*, Cham, Switzerland: Springer, 2023.
4. G. P. Gupta, *Industrial Internet of Things and Cyber-Physical Systems*, Boca Raton, FL, USA: CRC Press, 2022.
5. Qusay Mahmoud, *Getting Started with the Internet of Things: Connecting Sensors and Microcontrollers to the Cloud*, Piscataway, NJ, USA: IEEE Press, 2023.

**Online References**

1. ThingSpeak: <https://thingspeak.com>
2. Node-RED Documentation : <https://nodered.org/docs>
3. MQTT Organization : <https://mqtt.org>
4. Eclipse Paho: <https://www.eclipse.org/paho/>
5. HiveMQ: <https://www.hivemq.com/public-mqtt-broker/>
6. Modbus Organization: <https://modbus.org>

**Term Work:**

The term work should include **12 experiments**. Term work will be assessed as Continuous Internal Assessment Practical (CIAP).

**CIAP:**

- 25 Marks (Total Marks) = 20 Marks (Experiment) + 05 Marks (Attendance).
- The final certification and acceptance of term work ensure satisfactory performance of laboratory work and minimum passing marks in term work.

| Course Code | Course Name    | Teaching Scheme (Hrs.) |           |          | Credits Assigned |           |          |       |
|-------------|----------------|------------------------|-----------|----------|------------------|-----------|----------|-------|
|             |                | Theory                 | Practical | Tutorial | Theory           | Practical | Tutorial | Total |
| CSEPEL6012  | NFT & DeFi Lab | -                      | 02        | -        | --               | 01        | -        | 01    |

| Course Code | Course Name    | Examination Scheme |     |                   |      |      |       |
|-------------|----------------|--------------------|-----|-------------------|------|------|-------|
|             |                | Theory Marks       |     |                   | CIAP | ESEP | Total |
|             |                | Course Assessment  |     | ESE <sup>\$</sup> |      |      |       |
|             |                | ISE                | MSE |                   |      |      |       |
| CSEPEL 6012 | NFT & DeFi Lab | --                 | --  | --                | 25   | -    | 25    |

**Pre-requisite :**

1. CSEC 503: Introduction to Blockchain,

**Program Outcomes addressed:**

1. PO1: Engineering knowledge.
2. PO2: Problem analysis.
3. PO3: Design/ Development of solution.
4. PO4 Conduct Investigations of Complex Problems.
5. PO5 : Engineering Tool Usage
6. PO6: The Engineer and The World
7. PO11: Life-long Learning

**Lab Objectives:**

1. To understand blockchain basics, wallet setup, and DApp workflows.
2. To deploy and interact with smart contracts using Remix and Solidity.
3. To implement NFT standards (ERC-721, ERC-1155) and use IPFS for storage.
4. To create ERC-20 tokens and analyze real-world asset tokenization.
5. To explore DeFi concepts such as AMMs, lending, borrowing, and yield farming.
6. To study common DeFi security issues like reentrancy and apply safe coding practices.

**Lab Outcomes:**

Upon completion of the course, learners will be able to:

1. Understand blockchain basics, Ethereum ecosystem, wallets, and test networks.
2. Deploy and interact with smart contracts using Solidity and Remix IDE.
3. Implement NFT concepts and use IPFS for decentralized storage.
4. Develop ERC-20 tokens and analyze real-world asset tokenization.
5. Analyze DeFi concepts such as AMMs, lending, borrowing, and yield farming.
6. Evaluate blockchain security issues and design basic DApps using MetaMask and smart contracts..

| <b>Suggested List of Experiments: Students are required to complete 12 experiments</b> |                                                                                                                                                            | <b>LO</b> |
|----------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| <b>Sr. No.</b>                                                                         | <b>Title of Experiments</b>                                                                                                                                |           |
| 1.                                                                                     | A developer identifies blockchain development tools and configures a MetaMask wallet for test networks in a lab environment.                               | LO1       |
| 2.                                                                                     | A user explores Ethereum blockchain, testnets, gas fees, and smart contract deployment workflow to understand basic blockchain operations in a lab setup.. | LO1       |
| 3.                                                                                     | A developer deploys an ERC-721 NFT smart contract using Remix IDE and verifies the deployment on a test network..                                          | LO2       |
| 4.                                                                                     | A user creates NFT metadata and uploads JSON files to IPFS using Pinata or Web3.Storage for NFT minting.                                                   | LO3       |
| 5.                                                                                     | A developer implements an ERC-1155 multi-token smart contract and mints multiple tokens on a test network.                                                 | LO3       |
| 6.                                                                                     | A user creates and deploys a simple ERC-20 token using Solidity templates and tests token transactions on a test network.                                  | LO4       |
| 7.                                                                                     | A developer analyzes tokenization of real-world assets such as land, art, or gold using Excel-based simulation.                                            | LO4       |
| 8.                                                                                     | A user interprets AMM pricing behavior using the formula ( $x*y=k$ ) through spreadsheet or Python simulation in a lab environment.                        | LO5       |
| 9.                                                                                     | A developer demonstrates lending and borrowing operations on Aave testnet, including deposit, collateral, and borrowing actions.                           | LO5       |
| 10.                                                                                    | A user evaluates yield farming returns using a simulated liquidity pool calculator in a lab environment.                                                   | LO5       |
| 11.                                                                                    | A developer investigates a common DeFi vulnerability by simulating a reentrancy attack scenario in a controlled environment.                               | LO6       |
| 12.                                                                                    | A user evaluates gas consumption of smart contract execution on the Ethereum testnet to understand transaction cost efficiency.                            | LO6       |
| 13.                                                                                    | A developer analyzes Ethereum transaction details using Etherscan to understand blockchain activity and transparency.                                      | LO1       |
| 14.                                                                                    | A user designs a basic DApp workflow using MetaMask and Remix IDE for understanding decentralized application flow                                         | LO6       |
| 15.                                                                                    | A developer designs an NFT or DeFi mini-project using testnet tools to apply blockchain concepts in a practical scenario.                                  | LO6       |

#### **Textbooks:**

1. Bashir, *Mastering Blockchain*, 4th ed. Birmingham, UK: Packt Publishing, 2023.
2. D. Drescher, *Blockchain Basics: A Non-Technical Introduction in 25 Steps*. New York, NY, USA: Apress, 2017
3. A Lewis, *The Basics of Bitcoins and Blockchains*. San Francisco, CA, USA: Mango Publishing, 2018.
4. S. Kim, *DeFi for Dummies*. Hoboken, NJ, USA: Wiley, 2022.

#### **Reference books:**

1. Imran Bashir, *Mastering Blockchain: A Deep Dive into Distributed Ledgers, Consensus Protocols, Smart Contracts, DApps, NFTs and DeFi*, 3rd ed., Birmingham, U.K.: Packt Publishing, 2023.
2. Andreas M. Antonopoulos and Gavin Wood, *Mastering Ethereum: Building Smart Contracts and DApps*, Sebastopol, CA, USA: O'Reilly Media, 2019.
3. Arshdeep Bahga and Vijay Madisetti, *Blockchain Applications: A Hands-On Approach*, Hyderabad, India: Universities Press, 2022.
4. Campbell R. Harvey, Ashwin Ramachandran and Joey Santoro, *DeFi and the Future of Finance*, Hoboken, NJ, USA: Wiley, 2021.

### Online References

1. Ethereum Docs : <https://ethereum.org/en/developers/docs/standards/tokens/erc-721/>
2. OpenSea Developer Documentation : <https://docs.opensea.io/>
3. IPFS Documentation: <https://docs.ipfs.tech/>
4. Aave Documentation: <https://docs.aave.com/>
5. Uniswap Documentation: <https://docs.uniswap.org/>

### Term Work:

The term work should include 12 experiments. Term work will be assessed as Continuous Internal Assessment Practical (CIAP).

### CIAP:

- 25 Marks (Total Marks) = 20 Marks (Experiment) + 05 Marks (Attendance)
- The final certification and acceptance of term work ensure satisfactory performance of laboratory work and minimum passing marks in term work.

| Course Code        | Course Name                                                 | Teaching Scheme (Hrs.) |           |          | Credits Assigned |           |          |           |
|--------------------|-------------------------------------------------------------|------------------------|-----------|----------|------------------|-----------|----------|-----------|
|                    |                                                             | Theory                 | Practical | Tutorial | Theory           | Practical | Tutorial | Total     |
| <b>CSEPEL 6013</b> | <b>Vulnerability Assessment and Penetration Testing Lab</b> | --                     | <b>02</b> | --       | --               | <b>01</b> | --       | <b>01</b> |

| Course Code | Course Name                                          | Examination Scheme |     |     |      |      |       |
|-------------|------------------------------------------------------|--------------------|-----|-----|------|------|-------|
|             |                                                      | Theory Marks       |     |     | CIAP | ESEP | Total |
|             |                                                      | Course Assessment  |     | ESE |      |      |       |
|             |                                                      | ISE                | MSE |     |      |      |       |
| CSEPEL 6013 | Vulnerability Assessment and Penetration Testing Lab | --                 | --  | --  | 25   | --   | 25    |

**Pre-requisite:**

1. CSEL402: Computer Network
2. CSEL501: Cryptography and Network Security

**Program Outcomes Addressed:**

1. PO1: Engineering Knowledge
2. PO2: Problem Analysis
3. PO3: Design/Development of Solutions
4. PO5: Engineering Tool Usage
5. PO6: The Engineer and The World
6. PO7: Ethics
7. PO11: Life-Long Learning

**Lab Objectives:**

1. To develop hands-on skills in using hacking and reconnaissance tools for information gathering.
2. To perform vulnerability, network, and port scanning using industry-standard tools such as Nmap and Netcat.
3. To analyze network communication by capturing and inspecting packets using Wireshark.
4. To enumerate services and protocols (NFS, SMB, SMTP) to identify potential security weaknesses.
5. To conduct vulnerability detection and reporting using security scanners such as Nessus, Nikto, and Burp Suite.
6. To execute exploitation and vulnerability analysis using the Metasploit framework in a controlled lab environment.

**Lab Outcomes:**

After successful completion of the course, will be able to:

1. Identify and use ethical hacking and reconnaissance tools for information gathering.
2. Perform network, port, and vulnerability scanning using security tools.
3. Analyze captured network traffic to detect suspicious communication patterns.

4. Enumerate and assess exposed services and protocols for security weaknesses.
5. Evaluate vulnerabilities and generate reports using web and network security scanners.
6. Demonstrate exploitation and post-exploitation techniques using Metasploit.

| <b>Suggested List of Experiments:</b> Students are required to complete at least 12 experiments. |                                                                                                                                                                                                                                                                         |           |
|--------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| <b>Sr. No.</b>                                                                                   | <b>Title of Experiments</b>                                                                                                                                                                                                                                             | <b>LO</b> |
| 1                                                                                                | The task involves exploring and using different ethical hacking tools to understand their practical applications in identifying and mitigating security vulnerabilities.                                                                                                | LO1       |
| 2                                                                                                | The problem focuses on performing footprinting and reconnaissance to collect detailed information about a target system or network. This includes identifying publicly available data that may expose security weaknesses.                                              | LO1       |
| 3                                                                                                | The task is to practically analyze different types of vulnerability scanning such as network, port, and vulnerability scanning.                                                                                                                                         | LO2       |
| 4                                                                                                | The problem requires performing vulnerability scanning using OpenVAS to detect and analyze security flaws in a target system.                                                                                                                                           | LO2       |
| 5                                                                                                | Execute vulnerability scanning using various tools to identify weaknesses in systems and networks. The findings are to be analyzed to understand real-world security issues.                                                                                            | LO2       |
| 6                                                                                                | The problem involves conducting internal penetration testing by performing mapping, scanning, exploiting CVEs, and executing attacks such as sniffing, ARP poisoning, and DNS poisoning. The goal is to simulate real attack scenarios within a controlled environment. | LO2       |
| 7                                                                                                | Execute live network and port scanning using Nmap to identify open ports, active services, and system details.                                                                                                                                                          | LO2       |
| 8                                                                                                | The problem requires using Netcat to establish TCP/UDP connections, perform banner grabbing, and enable communication between systems.                                                                                                                                  | LO2       |
| 9                                                                                                | The task involves installing and using Wireshark to capture and analyze real-time network packets. The captured data is examined to understand traffic flow and detect anomalies.                                                                                       | LO3       |
| 10                                                                                               | The problem focuses on performing sniffing using various tools to capture network traffic and sensitive information. The exercise demonstrates potential risks and data exposure in unsecured networks.                                                                 | LO3       |
| 11                                                                                               | The task is to perform enumeration of services such as NFS, SMB, and SMTP to extract detailed system and network information.                                                                                                                                           | LO4       |
| 12                                                                                               | The problem involves installing and configuring Nessus for practical vulnerability assessment across different environments.                                                                                                                                            | LO5       |
| 13                                                                                               | The task requires executing vulnerability scans using Nessus to identify and classify system and network vulnerabilities.                                                                                                                                               | LO5       |
| 14                                                                                               | The problem involves assessing web applications using security testing tools to identify vulnerabilities such as injection flaws and misconfigurations.                                                                                                                 | LO5       |
| 15                                                                                               | The task is to perform vulnerability analysis and exploitation using Metasploit.                                                                                                                                                                                        | LO6       |

**Textbooks:**

1. M. Georgia Weidman, Penetration Testing: A Hands-On Introduction to Hacking, 2nd ed. San Francisco, CA, USA: No Starch Press, 2023.
2. M. Mohammad Beg, Mastering Kali Linux for Advanced Penetration Testing, 4th ed. Birmingham, U.K.: Packt Publishing, 2023.
3. M. Matt Walker, CEH Certified Ethical Hacker All-in-One Exam Guide, 5th ed. New York, NY, USA: McGraw-Hill, 2023.
4. L. Chris Sanders, Practical Packet Analysis: Using Wireshark to Solve Real-World Network Problems, 3rd ed. San Francisco, CA, USA: No Starch Press, 2017.
5. D. Dafydd Stuttard and M. Marcus Pinto, The Web Application Hacker's Handbook, 2nd ed. (reprint). Indianapolis, IN, USA: Wiley, 2021.

**Reference books:**

1. A. Allen Harper et al., Gray Hat Hacking: The Ethical Hacker's Handbook, 6th ed. New York, NY, USA: McGraw-Hill, 2022.
2. G. Gus Khawaja, Practical Web Penetration Testing, 2nd ed. Birmingham, U.K.: Packt Publishing, 2021.
3. P. Peter Kim, The Hacker Playbook 3, Charleston, SC, USA: Independently Published, 2018.
4. R. Glen D. Singh, Learn Kali Linux 2019, Birmingham, U.K.: Packt Publishing, 2019.
5. J. Ed Skoudis and T. Tom Liston, Counter Hack Reloaded, 2nd ed. Upper Saddle River, NJ, USA: Prentice Hall, 2006.

**Online Resources:**

1. Nmap Reference Guide: <https://nmap.org/book/man.html>
2. Wireshark Documentation: <https://www.wireshark.org/docs/>
3. Ncat Guide: <https://nmap.org/ncat/guide/>
4. Metasploit Documentation: <https://docs.metasploit.com/>
5. NPTEL Course: <https://nptel.ac.in/courses/106106129>
6. Coursera Course: <https://www.coursera.org/professional-certificates/google-cybersecurity>

**Term Work:**

Term work should consist of at least 12 experiments (Ensure that all the LOs are covered.)

The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Term work will be assessed as Continuous Internal Assessment Practical (CIAP).

**Term work Marks (CIAP):**

- 25 Marks (Total Marks) = 20 Marks (Experiment) + 05 Marks (Attendance)
- The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.

| Course Code        | Course Name                                 | Teaching Scheme (Hrs.) |           |          | Credits Assigned |           |          |       |
|--------------------|---------------------------------------------|------------------------|-----------|----------|------------------|-----------|----------|-------|
|                    |                                             | Theory                 | Practical | Tutorial | Theory           | Practical | Tutorial | Total |
| <b>CSEPEL 6014</b> | <b>Data Analytics and Visualization Lab</b> | --                     | 02        | --       | --               | 01        | --       | 01    |

| Course Code | Course Name                          | Examination Scheme |     |     |      |      |       |
|-------------|--------------------------------------|--------------------|-----|-----|------|------|-------|
|             |                                      | Theory Marks       |     |     | CIAP | ESEP | Total |
|             |                                      | Course Assessment  |     | ESE |      |      |       |
|             |                                      | ISE                | MSE |     |      |      |       |
| CSEPEL 6014 | Data Analytics and Visualization Lab | --                 | --  | --  | 25   | --   | 25    |

**Pre-requisite:**

1. CSEC301: Applied Mathematics III
2. CSEC304: Database Management System
3. CSEL304: Python Programming

**Program Outcomes Addressed**

1. PO1: Engineering Knowledge
2. PO2: Problem Analysis
3. PO3: Design/Development of Solutions
4. PO4: Conduct Investigations of Complex Problems
5. PO5: Engineering Tool Usage
6. PO9: Communication
7. PO11: Life-Long Learning

**Lab Objectives:**

1. To introduce students to data analytics tools in Python, R, Power BI, and Tableau.
2. To apply regression and forecasting algorithms on structured and IoT datasets.
3. To analyze time-series data using ARIMA and evaluate forecasting accuracy.
4. To extract insights from unstructured text and IoT device logs.
5. To perform data cleaning, exploration, and visualization using R and Python.
6. To create interactive dashboards using Business Intelligence tools.

**Lab Outcomes:**

Upon completion of this course, Learners will be able to:

1. Use Python/R analytics libraries for data preparation and modelling.
2. Apply linear, multiple, and logistic regression to real-world datasets.
3. Build and evaluate ARIMA models for time-series forecasting.
4. Extract keywords, sentiments, and patterns from unstructured text/log data.
5. Create effective visualizations and EDA using R and Python libraries.
6. Develop BI dashboards using Power BI and Tableau with IoT datasets.

**Suggested List of Experiments:** Students are required to complete at least 12 experiments.

| Sr. No. | Title of Experiments                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | LO  |
|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| 1       | Identify, compare, and recommend suitable data analytics tools (e.g., Python, R) for a startup dealing with large-scale big data generated from social media feeds (e.g., tweets, posts, comments, likes, and shares).                                                                                                                                                                                                                                                                                                                                                   | LO1 |
| 2       | Demonstrate data import, cleaning, and ETLT operations on a social media dataset (e.g., tweets, posts, comments, likes, and shares) to prepare it for analysis.                                                                                                                                                                                                                                                                                                                                                                                                          | LO1 |
| 3       | A social media analytics company wants to understand how different characteristics of a post influence its popularity. You are given a dataset containing information about various social media posts. The company aims to build a predictive model using Simple Linear Regression to estimate the number of likes a post will receive based on a single influencing factor. (Take Fields like Post_ID, Post_Length, Hashtags_Count, Post_Time, Followers_Count, Likes).                                                                                                | LO2 |
| 4       | An e-commerce company aims to enhance its sales forecasting system by analyzing how various product and customer-related factors impact product sales. The objective is to develop and evaluate a Multiple Linear Regression model to predict the number of units sold based on features such as pricing, discounts, and customer behavior.                                                                                                                                                                                                                              | LO2 |
| 5       | A healthcare organization aims to develop a predictive system to identify whether a patient is at risk of developing a chronic disease. Using patient health records such as age, BMI, blood pressure, and glucose level, the objective is to build a Logistic Regression model to classify patients into "High Risk" or "Low Risk" categories and evaluate its performance.                                                                                                                                                                                             | LO2 |
| 6       | Design a regression-based system to predict normal sensor behavior and detect anomalies indicating potential faults in industrial equipment.                                                                                                                                                                                                                                                                                                                                                                                                                             | LO2 |
| 7       | A retail company analyzing historical sales data wants to understand how its monthly product demand changes over time. Using time series data, identify and analyze underlying patterns such as trend, seasonality, and irregular variations through decomposition techniques.                                                                                                                                                                                                                                                                                           | LO3 |
| 8       | An energy distribution company faces challenges in planning and managing electricity supply due to fluctuating demand patterns influenced by seasonal variations, weather conditions, and user consumption behaviour. To address this, required to analyse historical energy usage data and Build ARIMA model for Time Series Forecasting.                                                                                                                                                                                                                               | LO3 |
| 9       | A smart agriculture system collects historical temperature data from field sensors to support efficient irrigation planning. Using this data, implement ARIMA/ARMA models to forecast future temperature variations and help optimize water usage and crop management decisions.                                                                                                                                                                                                                                                                                         | LO3 |
| 10      | A large e-commerce company collects massive volumes of unstructured textual data from multiple sources such as customer reviews, product feedback forms, support chat logs, and social media comments. This data contains valuable insights about customer satisfaction, product issues, and service quality. However, the raw text is highly unstructured, noisy, and inconsistent, making it difficult to analyze directly. Demonstrates how unstructured textual data can be transformed into meaningful information using text pre-processing techniques and TF-IDF. | LO4 |
| 11      | An IoT system monitoring platform collects large volumes of device log data generated from connected sensors and smart devices. Perform text analytics on these IoT device logs to identify error messages, detect recurring alert patterns, and extract meaningful insights for system reliability and fault detection.                                                                                                                                                                                                                                                 | LO4 |

|    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |     |
|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| 12 | A school administration system collects student academic performance data across different subjects such as Mathematics, Science, English, and Social Studies. The dataset also includes attributes like attendance percentage, study hours per week, and exam scores. The school management wants to understand how students are performing overall and whether factors like attendance and study hours influence academic results. However, the raw data in tabular form is difficult to interpret for decision-making. To address this, Develop Data Visualizations for Exploratory Analysis. | LO5 |
| 13 | A digital marketing analytics team analyzes campaign performance data collected from multiple channels such as social media, email, and web advertising. Develop advanced data visualizations to identify patterns and relationships among key metrics to support data-driven marketing decisions.                                                                                                                                                                                                                                                                                               | LO5 |
| 14 | A smart city project collects data from traffic sensors and environmental monitors. The objective is to perform exploratory data analysis to understand traffic density patterns and pollution levels across different regions.                                                                                                                                                                                                                                                                                                                                                                  | LO5 |
| 15 | A logistics company wants to improve operational efficiency. The objective is to design and develop interactive dashboards to visualize delivery performance, shipment delays, and warehouse utilization for decision-making.                                                                                                                                                                                                                                                                                                                                                                    | LO6 |

#### Textbooks:

1. MC Education Services, *Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data*, 1st ed., Wiley, 2015.
2. Bharti Motwani, *Data Analytics Using Python*, 1st ed., Wiley India Pvt. Ltd., 2020.
3. P. Bruce, A. Bruce & P. Gedeck, *Practical Statistics for Data Scientists: 50+ Essential Concepts Using R and Python*, 2nd ed., O'Reilly Media, 2020.
4. G. Miner & T. Hill, *Practical Text Mining and Statistical Analysis for Non-Structured Text Data Applications*, 1st ed.
5. Dan Clark, *Beginning Microsoft Power BI: A Practical Guide to Self-Service Data Analytics*, 1st ed.

#### Reference books:

1. Bharti Motwani, *Data Analytics using R*, 1st ed., Wiley (India), 2020.
2. Wes McKinney, *Python for Data Analysis*, 3rd ed., O'Reilly Media, 2022.
3. Neha Singh Rajput & Sulabh Bhatt, *Visual Analytics Using Tableau: Structured Approach for Turning Raw Data to Powerful Insights*, 1st ed., BPB Publications, 2024.
4. M. S. Hariharan, *IoT Data Analytics Using Python*, 1st ed., BPB Publications, 2023.
5. Qusay F. Hassan, *Internet of Things A to Z: Technologies and Applications*, 1st ed., Wiley, 2018.

#### Online Resources

1. NPTEL Course: [https://onlinecourses.swayam2.ac.in/imb25\\_mg218/preview](https://onlinecourses.swayam2.ac.in/imb25_mg218/preview)
2. NPTEL Course: [https://onlinecourses.nptel.ac.in/noc19\\_ge20/preview](https://onlinecourses.nptel.ac.in/noc19_ge20/preview)

#### Software Tools:

1. Python
2. R & RStudio
3. Power BI Desktop
4. Tableau Public
5. Spreadsheet Tool

**Term Work:**

- Term work should consist of at least **12 experiments**. Term work will be assessed as Continuous Internal Assessment Practical (CIAP).

**Term work Marks (CIAP):**

- 25 Marks (Total Marks) = 20 Marks (Experiment) + 05 Marks (Attendance).
- The final certification and acceptance of term work ensure satisfactory performance of laboratory work and minimum passing marks in term work.

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| Course Code | Course Name     | Credits Assigned |           |          |       |
|-------------|-----------------|------------------|-----------|----------|-------|
|             |                 | Theory           | Practical | Tutorial | Total |
| CSEP601     | Major Project I | --               | 2         | --       | 2     |

| Course Code | Course Name     | Examination Scheme |     |     |      |      |       |
|-------------|-----------------|--------------------|-----|-----|------|------|-------|
|             |                 | Theory Marks       |     |     | CIAP | ESEP | Total |
|             |                 | Course Assessment  |     | ESE |      |      |       |
|             |                 | ISE                | MSE |     |      |      |       |
| CSEP601     | Major Project I | --                 | --  | --  | 25   | 25   | 50    |

**Program Outcomes addressed:**

1. PO1: Engineering knowledge.
2. PO2: Problem Analysis.
3. PO3: Design/Development of Solutions.
4. PO4: Conduct Investigations of Complex Problems.
5. PO5: Engineering Tool Usage.
6. PO6: The Engineer and The World.
7. PO7: Ethics.
8. PO8: Individual and Collaborative Team work.
9. PO9: Communication.
10. PO10: Project Management and Finance.
11. PO11: Life-Long Learning.

**Objectives:**

1. Investigate and evaluate prominent literature to come with application-oriented project topics in connection with the curriculum.
2. Study and develop an outline for thinking and practice that illuminates and brings insight to the design and implementation aspects with respect to the project topic.
3. Design and create practical resources and solution aspect for the design and implementation.
4. Present an organised exploratory framework, while understanding the documentary deliverables within established academic practices and/ or ideas.
5. Offer inquiry-based argumentation / presentation along with project implementation
6. To promote self-learning and research-oriented thinking.

**Outcomes:** Upon completion of this course, learners will be able to:

1. Perform extensive Review of Literature from diverse knowledge banks or through interactions with Industry experts.
2. Developing or Creating ideas capable of addressing industrial or social solutions to identified problem domains.
3. Acquire knowledge of tools & technologies and application of their expertise in creating project implementation and deliverables.
4. Implement solutions using appropriate technologies, engineering practices, and version control.
5. Test and validate the system through structured test cases, datasets, and simulations.
6. Compose technical documentation, present project outcomes, and demonstrate teamwork, ethics, and self-learning.

## **1. Guidelines for Project topic selection Process to be defined and followed:**

### **1.1 General Guidelines**

- a. Project orientation can be given at the end of fifth semester.
- b. Students should be informed about the domain and domain experts whose guidance can be taken before selecting projects.
- c. Students can select the problem statement from the Industry and provide technology solution as capstone project. Capstone projects in engineering study are considered important as it allow students to integrate and apply the knowledge and skills acquired throughout their academic program and effectively demonstrating their learning of programme by tackling a real-world problem, ultimately keeping them well prepared for the job market
- d. Student's should be recommended to refer papers from reputed conferences/ journals like IEEE, Elsevier, ACM etc. which are not more than 3 years old for review of literature.
- e. Students can certainly take ideas from anywhere, but be sure that they should evolve them in the unique way to suit their project requirements. Students can be informed to refer Digital India portal, SIH portal or any other hackathon portal for problem selection.

### **1.2 Topics can be finalized with respect to following criterion:**

- a. Topic Selection: The topics selected should be novel in nature (Product based, Application based or Research based) or should work towards removing the lacuna in currently existing systems.
- b. Technology Used: Use of latest technology or modern tools can be encouraged.
- c. Students should not repeat work done previously (work done in the last three years).
- d. Project work must be carried out by the group of at least 2 students and maximum 4.
- e. The project work can be undertaken in a research institute or organization/Industry/any business establishment. (out-house projects)
- f. The Capstone Project- problems must be related to the programme or may be interdisciplinary, based on the industry expected outcomes. The individual students have different aptitudes and strengths. Project work, therefore, should match the strengths of students. For this purpose, students should be asked to identify the type of project work they would like to execute.
- g. Project shall address National Thrust area such as Environment, Digitization, Automation, sustainability and predefined Sustainable development goals(SDGs).
- h. The project proposal presentations can be scheduled according to the domains and should be judged by faculty who are expert in the domain.
- i. Head of department and senior staff along with project coordinators will take decision regarding final selection of projects.
- j. Guide allocation should be done and students have to submit weekly progress report to the internal guide.
- k. Internal guide has to keep track of the progress of the project and also has to maintain attendance report. This progress report can be used for awarding term work marks.
- l. In case of industry/ out-house projects, visit by internal guide will be preferred and external members can be called during the presentation at various levels.

### **1.3 Deployment Requirement**

- a. Each project must include a deployment phase, ensuring the solution is usable in a real-world or simulated environment.

#### **Examples of deployment include:**

- Web application hosted on cloud/server
- Mobile application (APK/Test version/Play Store)
- Industrial automation system implemented or simulated
- AI/ML model deployed via API or dashboard
- IoT system with real-time monitoring and control

## **2. Guidelines for Assessment of Major Project I:**

### **1.1 Term Work Evaluation (CIAP)**

- a. A Review/Progress Monitoring Committee shall be constituted by the Head of Department. **Major Project I** shall be evaluated continuously, with a minimum of two reviews per semester.
- b. Continuous assessment should also emphasize individual performance, including each student's contribution, understanding of the project, and responses during review interactions.
- c. Project report to be submitted as per the guidelines issued by the department.
- d. Term work will be assessed as Continuous Internal Assessment Practical (CIAP).

### **2.2 Distribution of marks**

The distribution of Term Work marks for the semester shall be as follows:

- a. Marks by Guide/Supervisor based on Logbook: 10
- b. Marks by Review Committee: 10
- c. Quality of Project Report: 05

### **1.3 Evaluation Rubrics CIAP (Term work);**

- a. Quality of literature survey and need identification
- b. Clarity of problem definition
- c. Innovation and creativity
- d. Feasibility and justification of approach
- e. Cost effectiveness and societal/environmental impact (SDGs)
- f. Quality of system design and use of engineering norms
- g. Implementation quality and functioning of prototype
- h. Effective use of technical skill sets and tools
- i. Teamwork, leadership, and individual contribution
- j. Clarity in documentation, presentation, and communication
- k. Deployment readiness and implementation feasibility
- l. Usability, scalability, and real-world applicability of the deployed solution

### **1.4 ESEP (Practical/Oral) Examination:**

- a. **Major Project I** shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organizations having experience of more than five years approved by the head of Institution.
- b. Students shall be motivated to publish a paper based on the work in Conferences/students competitions.
- c. End-semester Practical / oral exam will be held based on the above syllabus and will be conducted as End Semester Examination Practical (ESEP).

### **1.5 Evaluation Rubrics ESEP (Practical / Oral):**

- a. Problem identification and clarity
- b. Innovation in solution
- c. Feasibility and societal impact
- d. Working model functionality
- e. Effective use of engineering tools
- f. Adherence to standards and norms
- g. Teamwork and individual contribution
- h. Communication skills
- i. Deployment quality (hosting, execution, usability, and performance)