

## **Curriculum and Syllabi**

### **M.E. Computer Science and Engineering**

#### **Semesters I to IV**

#### **Regulations 2024**

# **Dr.Mahalingam College of Engineering and Technology**

## **Department of Computer Science and Engineering**

### **Vision**

To develop engineers with global employability, entrepreneurship capability, research focus and social responsibility

### **Mission**

- To develop internationally competent engineers in dynamic IT field by providing state-of-art academic environment and industry driven curriculum
- To motivate and guide students to take up higher studies and establish entrepreneurial ventures
- To enrich the department through committed and technically sound faculty team with research focus in thrust areas
- To undertake societal problems and provide solutions through technical innovations and projects in association with the industry, society and professional bodies

## **Dr.Mahalingam College of Engineering and Technology**

### **Programme: M.E. Computer Science and Engineering**

#### **Programme Educational Objectives (PEOs) - Regulations 2024**

After 2 to 3 years of completion of the programme the graduates will be able to:

**PEO1. Domain Expertise and Leadership:** Exhibit sustained knowledge in the field of Computer Science and Engineering and possess leadership capability in their professional careers.

**PEO2. Problem Solving:** Design optimal computing solutions for engineering problems to meet the needs of individuals, organizations and society.

**PEO3. Lifelong Learning and Research:** Engage in lifelong learning and contribute towards independent and collaborative scientific research

#### **Programme Outcomes (POs) - Regulations 2024**

On successful completion of the programme the graduates will be able to:

**PO1. Scholarship of Knowledge:** Acquire in-depth knowledge in Computer Science and Engineering with an ability to discriminate, evaluate, analyse and synthesize knowledge.

**PO2. Research Skill:** Investigate suitable literature and conduct experiments apply appropriate research methodologies, techniques and tools to demonstrate higher order skill and contribute to the development of technological knowledge in Computer Science and Engineering.

**PO3. Usage of Modern Tools:** Develop and apply appropriate techniques, resources and modern engineering and IT tools, including prediction and modeling, to complex engineering activities.

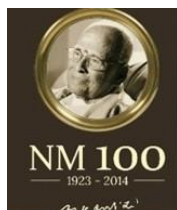
**PO4. Communication:** Communicate effectively regarding complex engineering activities, write effective reports and design documentation by adhering to appropriate standards and make effective presentations

## **Programme Specific Outcomes (PSOs) - Regulations 2024**

On successful completion of the programme the graduates will be able to:

**PSO1. Data Management:** Analyze large scale data and provide scalable solutions for real world problems.

**PSO2. Computing and Communication:** Design and evaluate techniques for secure computing and communication.



**Department of Computer Science and Engineering**  
**M.E - Computer Science and Engineering**  
**2024 Regulations – Curriculum for Semesters I to IV**

**Semester I**

| Course Code  | Course Title                       | Hours/Week |          |          | Credits   | Marks      | Common to Programmes |
|--------------|------------------------------------|------------|----------|----------|-----------|------------|----------------------|
|              |                                    | L          | T        | P        |           |            |                      |
| 24MAT102     | Applied Probability and Statistics | 3          | 0        | 0        | 3         | 100        | -                    |
| 24CPT101     | Data Structures and Algorithms     | 3          | 0        | 0        | 3         | 100        | -                    |
| 24CPT102     | Network Design and Management      | 3          | 0        | 0        | 3         | 100        | -                    |
| XXXXXXX      | Professional Elective - I          | 3          | 0        | 0        | 3         | 100        | -                    |
| 24CCT101     | Research Methodology and IPR       | 3          | 0        | 0        | 3         | 100        | All                  |
| 24CPL101     | Data Structures Laboratory         | 0          | 0        | 4        | 2         | 100        | -                    |
| 24CPL102     | Networks Laboratory                | 0          | 0        | 4        | 2         | 100        | -                    |
| 24SHA101     | English for Research Paper Writing | 2          | 0        | 0        | -         | 100        | All                  |
| <b>Total</b> |                                    | <b>17</b>  | <b>0</b> | <b>8</b> | <b>19</b> | <b>800</b> |                      |

**Semester II**

| Course Code  | Course Title                                   | Hours/Week |          |           | Credits   | Marks      | Common to Programmes |
|--------------|------------------------------------------------|------------|----------|-----------|-----------|------------|----------------------|
|              |                                                | L          | T        | P         |           |            |                      |
| 24CPT201     | Data Analytics                                 | 3          | 0        | 0         | 3         | 100        | -                    |
| 24CPT202     | Machine Learning                               | 3          | 0        | 0         | 3         | 100        | -                    |
| 24CPT203     | Modern Operating Systems                       | 3          | 0        | 0         | 3         | 100        | -                    |
| XXXXXXX      | Professional Elective - II                     | 3          | 0        | 0         | 3         | 100        | -                    |
| XXXXXXX      | Professional Elective – III                    | 3          | 0        | 0         | 3         | 100        | -                    |
| 24CPL201     | Data Analytics and Machine Learning Laboratory | 0          | 0        | 4         | 2         | 100        | -                    |
| 24CPL202     | Research Paper Seminar                         | 0          | 0        | 2         | 1         | 100        | -                    |
| 24SHA201     | Teaching and Learning in Engineering           | 0          | 0        | 4         | -         | 100        | All                  |
| <b>Total</b> |                                                | <b>15</b>  | <b>0</b> | <b>10</b> | <b>18</b> | <b>800</b> |                      |

### Semester III

| Course Code  | Course Title                 | Hours/Week |          |           | Credits   | Marks      | Common to Programmes |
|--------------|------------------------------|------------|----------|-----------|-----------|------------|----------------------|
|              |                              | L          | T        | P         |           |            |                      |
| XXXXXXX      | Professional Elective – IV   | 3          | 0        | 0         | 3         | 100        | -                    |
| XXXXXXX      | Professional Elective – V    | 3          | 0        | 0         | 3         | 100        | -                    |
| XXXXXXX      | Open Elective/ Online Course | 3          | 0        | 0         | 3         | 100        | -                    |
| 24CPP301     | Project – I                  | 0          | 0        | 20        | 10        | 200        | -                    |
| <b>Total</b> |                              | <b>9</b>   | <b>0</b> | <b>20</b> | <b>19</b> | <b>500</b> |                      |

### Semester IV

| Course Code  | Course Title | Hours/Week |          |           | Credits   | Marks      | Common to Programmes |
|--------------|--------------|------------|----------|-----------|-----------|------------|----------------------|
|              |              | L          | T        | P         |           |            |                      |
| 24CPP401     | Project – II | 0          | 0        | 32        | 16        | 400        | -                    |
| <b>Total</b> |              | <b>0</b>   | <b>0</b> | <b>32</b> | <b>16</b> | <b>400</b> |                      |

**Total Credits: 72**

### Professional Electives (Semesters I to III)

| Course code | Course Title                        | Hours/Week |   |   | Credits | Marks |
|-------------|-------------------------------------|------------|---|---|---------|-------|
|             |                                     | L          | T | P |         |       |
| 24CPE001    | Advanced Computer Architecture      | 3          | 0 | 0 | 3       | 100   |
| 24CPE002    | Advanced Databases                  | 3          | 0 | 0 | 3       | 100   |
| 24CPE003    | Compiler Optimization Techniques    | 3          | 0 | 0 | 3       | 100   |
| 24CPE004    | Digital Media Processing Techniques | 3          | 0 | 0 | 3       | 100   |
| 24CPE005    | Soft Computing                      | 3          | 0 | 0 | 3       | 100   |
| 24CPE006    | Cloud Computing and IoT             | 3          | 0 | 0 | 3       | 100   |
| 24CPE007    | GPU Architectures and Computing     | 3          | 0 | 0 | 3       | 100   |
| 24CPE008    | Security in Computing               | 3          | 0 | 0 | 3       | 100   |
| 24CPE009    | Natural Language Processing         | 3          | 0 | 0 | 3       | 100   |
| 24CPE010    | Information Retrieval               | 3          | 0 | 0 | 3       | 100   |
| 24CPE011    | Social Network Mining               | 3          | 0 | 0 | 3       | 100   |
| 24CPE012    | Blockchain                          | 3          | 0 | 0 | 3       | 100   |
| 24CPE013    | Embedded System Design              | 3          | 0 | 0 | 3       | 100   |
| 24CPE014    | Extended Reality                    | 3          | 0 | 0 | 3       | 100   |
| 24CPE015    | Advanced Software Engineering       | 3          | 0 | 0 | 3       | 100   |

| Course code | Course Title              | Hours/Week |   |   | Credits | Marks |
|-------------|---------------------------|------------|---|---|---------|-------|
|             |                           | L          | T | P |         |       |
| 24CPE016    | Nature Inspired Computing | 3          | 0 | 0 | 3       | 100   |
| 24CPE017    | Wireless Security         | 3          | 0 | 0 | 3       | 100   |
| 24CPE018    | Industrial IOT            | 3          | 0 | 0 | 3       | 100   |
| 24CPE019    | Deep Learning Techniques  | 3          | 0 | 0 | 3       | 100   |
| 24CPE020    | Reinforcement Learning    | 3          | 0 | 0 | 3       | 100   |

### List of Open Electives

| Course code | Course Title                 | Hours/Week |   |   | Credits | Marks |
|-------------|------------------------------|------------|---|---|---------|-------|
|             |                              | L          | T | P |         |       |
| 24CPO301    | Business Analytics           | 3          | 0 | 0 | 3       | 100   |
| 24CPO302    | Cyber Security and Forensics | 3          | 0 | 0 | 3       | 100   |

### Syllabus - Semester I

|                                              |                   |                                                         |                       |
|----------------------------------------------|-------------------|---------------------------------------------------------|-----------------------|
| <b>Course Code: 24MAT102</b>                 |                   | <b>Course Title: Applied Probability and Statistics</b> |                       |
| <b>Course Category: Foundation Course</b>    |                   | <b>Course Level: Introductory</b>                       |                       |
| <b>L:T:P(Hours/Week)</b><br><b>3 : 0 : 0</b> | <b>Credits: 3</b> | <b>Total Contact Hours:</b><br><b>45</b>                | <b>Max Marks: 100</b> |

#### **Course Objectives:**

The course is intended to impart knowledge on Probability and random variables. The course intends to provide exposure the small / large sample tests through tests of hypothesis. To enable the students to use the concepts of multivariate analysis.

#### **Module I**

**23 Hours**

**Probability Distributions:** Random variables - Moments, Moment generating function - Probability distributions: Binomial, Poisson, Exponential and Normal distributions - Functions of one Random variable. **Two Dimensional Random Variables:** Joint distributions - Marginal and Conditional distributions - Covariance - Correlation Regression - Functions of two random variables Central limit theorem. **Estimation Theory:** Point Estimation: Properties of estimators-Unbiased Estimators-Curve fitting by Principle of least squares.

#### **Module II**

**22 Hours**

**Testing of Hypothesis:** Sampling distributions - Statistical hypothesis - Small sample test: t test for single mean and difference of means - F test. Chisquare test for goodness of fit and independence of attributes - ANOVA: One way and Two way classification – Latin Square Design. **Multivariate Analysis:** Random vectors and matrices – Mean vectors and covariance matrices – Multivariate normal density and its properties – Principal components – Population principal components – Principal components from standardized variables.

| Course Outcomes                                                                                     | Cognitive Level |
|-----------------------------------------------------------------------------------------------------|-----------------|
| At the end of this course, students will be able to:                                                |                 |
| CO1: Demonstrate a thorough understanding of the principles of probability theory and distributions | Apply           |
| CO2: Calculate the marginal and conditional distributions of bivariate random variable              | Apply           |
| CO3: Compute point estimation of parameters and fit a curve to the given data.                      | Apply           |
| CO4: Formulate and test hypotheses using small and large sample tests.                              | Apply           |
| CO5: Apply multivariate analysis techniques in the analysis of data                                 | Apply           |

### Text Books:

- T1. Irwin Miller, Marylees Miller, "John E. Freund's Mathematical Statistics with Applications", 7<sup>th</sup> Edition, Pearson Education Limited, 2014.
- T2. Johnson, R.A. Miller and Freund's, "Probability and Statistics for Engineers", 7<sup>th</sup> Edition, Prentice Hall of India, 2005.

### Reference Books:

- R1. Jay L. Devore, "Probability and Statistics for Engineering and the Sciences", 8<sup>th</sup> Edition, Cengage Learning, 2012.
- R2. Richard A. Johnson and Dean W. Wichern, "Applied Multivariate Statistical Analysis", 8<sup>th</sup> Edition, Pearson Education, Asia, 2002.
- R3. Anderson. T.W, "An introduction to Multivariate Statistical Analysis", John Wiley and Sons, 2003.

### Web References:

1. <https://archive.nptel.ac.in/courses/111/105/111105090/>
2. <https://archive.nptel.ac.in/courses/111/105/111105041/>

|                                              |                   |                                                     |                       |
|----------------------------------------------|-------------------|-----------------------------------------------------|-----------------------|
| <b>Course Code: 24CPT101</b>                 |                   | <b>Course Title: Data Structures and Algorithms</b> |                       |
| <b>Course Category: Professional Core</b>    |                   | <b>Course Level: Practice</b>                       |                       |
| <b>L:T:P(Hours/Week)</b><br><b>3 : 0 : 0</b> | <b>Credits: 3</b> | <b>Total Contact Hours:</b><br><b>45</b>            | <b>Max Marks: 100</b> |

### **Course Objectives:**

The course is intended to impart knowledge on advanced data structures and algorithm design strategies. The course aims to enable the learners to identify the suitable data structure and design algorithms for problem solving.

### **Module I**

**22 Hours**

**Lists:** Linked lists - Skip lists - Self-organizing lists. **Balanced Trees:** AVL Trees – Treaps - Multiway Search Trees: B-Trees - B+ Trees. **Search Trees:** k-d Trees - R-Trees – Tries - Suffix Trees and Arrays.

### **Module II**

**23 Hours**

Theory of NP Completeness - Satisfiability problem – Cooks Theorem – NP Complete problems. **Randomized Algorithms:** Primality Testing - Closest pair problem - Pattern matching. **Approximation Algorithms:** Node cover problem - Bin-packing - Polynomial Time Approximation Schemes: 0/1 Knapsack problem. **Online Algorithms:** k-server problem - Bipartite matching - Convex Hull problem.

| Course Outcomes                                                             | Cognitive Level |
|-----------------------------------------------------------------------------|-----------------|
| At the end of this course, students will be able to:                        |                 |
| CO1:Implement various operations on advanced data structures                | Apply           |
| CO2:Solve search problems using the appropriate data structure              | Apply           |
| CO3:Choose the best suited algorithm design paradigm for solving a problem. | Evaluate        |
| CO4:Design efficient algorithms for real world applications.                | Create          |

### Text Books:

- T1. Adam Drozdek, "Data Structures and Algorithms in Java", 4<sup>th</sup> Edition, Cengage Learning, 2013.
- T2. R.C.T. Lee, S.S. Tseng, R.C. Chang and Y.T.Tsai, "Introduction to the Design and Analysis of Algorithms A Strategic Approach", Tata McGraw Hill, 2012.

### Reference Books:

- R1. Charles E. Leiserson, Ronald Rivest, Thomas H. Cormen and Clifford Stein, "Introduction to Algorithms", 4<sup>th</sup> Edition, MIT Press, 2022.
- R2. Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekaran "Fundamentals of Computer Algorithms", 2<sup>nd</sup> Edition, Universities press, 2008.
- R3. Mark A. Weiss, "Data Structures and Algorithm Analysis in Java", 3<sup>rd</sup> Edition, Pearson Education, 2012.

### Web References:

- 1.<https://www.coursera.org/specializations/data-structures-algorithms>
- 2.<http://visualalgo.net>

|                                           |                  |                                                    |                      |
|-------------------------------------------|------------------|----------------------------------------------------|----------------------|
| <b>Course Code: 24CPT102</b>              |                  | <b>Course Title: Network Design and Management</b> |                      |
| <b>Course Category: Professional Core</b> |                  | <b>Course Level: Practice</b>                      |                      |
| <b>L:T:P(Hours/Week)</b><br><b>3:0:0</b>  | <b>Credits:3</b> | <b>Total Contact Hours:45</b>                      | <b>Max Marks:100</b> |

### **Course Objectives:**

The course is intended to impart knowledge on network management and quality of service. The course intends to provide exposure on designing reliable networks, virtualization and effective management techniques.

### **Module I**

**22 Hours**

TCP/IP Network Architecture – Routers and Switches – Reliable Data Service – Sliding Window Protocol – Congestion Control and Avoidance Algorithms – Measuring and Managing Network Congestion – Internet Addressing – IPv4 and IPv6 Addressing scheme – Classless Interdomain Routing – DHCP – Routing Protocols: Distance Vector, Link State Routing – Error and Control Messages – Wireless Networks – IEEE 80.2.11 – Zigbee – Mobility and Mobile IP – Wireless Sensor Networks.

### **Module II**

**23 Hours**

QoS Tools – Queuing and Scheduling Algorithms – Random Early Detection – Differentiated Services – QoS in LTE and 5G Networks – Network Virtualization – Virtual LANs – Open Flow Technology – Tunneling and Encapsulation – Network Address Translation – Software Defined Networks – Network Management – MIB – SNMP and Security.

| <b>Course Outcomes</b>                                                                                           | <b>Cognitive Level</b> |
|------------------------------------------------------------------------------------------------------------------|------------------------|
| At the end of this course, students will be able to:                                                             |                        |
| CO1:Analyze the working of various TCP congestion control techniques in wired and wireless networks              | Analyze                |
| CO2:Design wired/ wireless network with suitable IP addressing using appropriate routing protocol                | Create                 |
| CO3:Analyze the quality of service offered in various real time applications                                     | Analyze                |
| CO4:Compare the performance of a network after applying virtualization concepts and network management protocols | Analyze                |

### **Text Books:**

- T1. James F. Kurose, Keith W. Ross, "Computer Networking – A top down Approach Featuring the Internet", 8<sup>th</sup> Edition, Pearson Education, 2021.
- T2. Miguel Barreiros, Peter Lundqvist, "QoS Enabled Networks: Tools and Foundations", 2<sup>nd</sup> Edition, John Wiley & Sons, 2016

### **Reference Books:**

- R1.Christos N Houmkozis, George A Rovithakis, "End-to-End Adaptive Congestion Control in TCP/IP Networks", CRC Press, 2017.
- R2.Douglas E. Comer, "Internetworking with TCP/IP: Principles, Protocol and Architecture Volume I", 6<sup>th</sup> Edition, Pearson Education, 2014.
- R3.Larry Peterson, Carmelo Cascone, Bruce Davie, "Software-Defined Networks: A Systems Approach", Systems Approach LLC, 2021.

### **Web References:**

1. <https://archive.nptel.ac.in/courses/106/105/106105183/>
2. <https://nptel.ac.in/courses/106106091>

|                                           |                  |                                                   |                      |
|-------------------------------------------|------------------|---------------------------------------------------|----------------------|
| <b>Course Code: 24CCT101</b>              |                  | <b>Course Title: Research Methodology and IPR</b> |                      |
| <b>Course Category: Professional Core</b> |                  | <b>Course Level: Introductory</b>                 |                      |
| <b>L:T:P(Hours/Week)</b><br><b>3:0:0</b>  | <b>Credits:3</b> | <b>Total Contact Hours:45</b>                     | <b>Max Marks:100</b> |

### **Course Objectives:**

The course is intended to describe the attitude measurements, scales and sampling methods and to apply hypotheses testing in research problem. Elucidate the research report writing and presentation effectively to encourage applying for patent and copyrighting for their innovative works.

### **Module I**

**22 Hours**

**Overview of Research Methodology:** Research methodology – definition, mathematical tools for analysis, Types of research, exploratory research, conclusive research, modeling research, algorithmic research, Research process Data collection methods- Primary data – observation method, personal interview, telephonic interview, mail survey, questionnaire design. Secondary data- internal sources of data, external sources of data.

**Attitude Measurements, Scales and Sampling Methods:** Scales – measurement, Types of scale – Thurstone's Case V scale model, Osgood's Semantic Differential scale, Likert scale, Q- sort scale. Sampling methods- Probability sampling methods – simple random sampling with replacement, simple random sampling without replacement, stratified, sampling, cluster sampling. Non- probability sampling method– convenience.

### **Module II**

**23 Hours**

**Hypotheses Testing:** Hypotheses testing – Testing of hypotheses concerning means (one mean and difference between two means -one tailed and two tailed tests).

**Report Writing and Presentation:** Report writing- Types of report, guidelines to review report, typing instructions, oral presentation.

**Patenting:** Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

| <b>Course Outcomes</b>                                            | <b>Cognitive Level</b> |
|-------------------------------------------------------------------|------------------------|
| At the end of this course, students will be able to:              |                        |
| CO1: Apply the attitude measurements, scales and sampling methods | Apply                  |
| CO2: Apply hypotheses testing in research problem                 | Apply                  |
| CO3: Apply the patent and copyright for their innovative works    | Apply                  |

### **Reference Books:**

- R1. Panneerselvam, R, "Research Methodology", Prentice-Hall of India, 2004.
- R2. Kumar, Ranjit, "Research Methodology: A Step by Step Guide for beginners", London Sage Publications, 2005.
- R3. Halbert, "Resisting Intellectual Property", Taylor & Francis Publications, 2007.
- R4. Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New Technological Age", Clause 8 Publishing, 2016
- R5. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand Publications, 2008

|                                           |                  |                                                 |                       |
|-------------------------------------------|------------------|-------------------------------------------------|-----------------------|
| <b>Course Code: 24CPL101</b>              |                  | <b>Course Title: Data Structures Laboratory</b> |                       |
| <b>Course Category: Professional Core</b> |                  | <b>Course Level: Practice</b>                   |                       |
| <b>L:T:P(Hours/Week)</b><br><b>0:0:4</b>  | <b>Credits:2</b> | <b>Total Contact Hours:60</b>                   | <b>Max Marks: 100</b> |

### **Course Objective:**

The course is intended to impart knowledge on problem solving by choosing the ideal data structure and algorithm design paradigm.

### **List of Experiments:**

1. Implementation of lists
2. Implementation of AVL Tree
3. Implementation of Treaps
4. Implementation of B-Trees
5. Implementation of k-d trees
6. Implementation of Tries
7. Implementation of Suffix Trees

Problem solving using:

8. Randomized algorithms
9. Approximation algorithms
10. Online algorithms

| Course Outcomes                                                                                          | Cognitive Level |
|----------------------------------------------------------------------------------------------------------|-----------------|
| At the end of this course, students will be able to:                                                     |                 |
| CO1:Develop algorithms to implement operations on various data structures                                | Apply           |
| CO2:Design efficient algorithms using suitable algorithm design paradigm for solving real-world problems | Create          |

### Reference Books:

- R1. Adam Drozdek, “Data Structures and Algorithms in Java”, 4<sup>th</sup> Edition, Cengage Learning, 2013.
- R2. R.C.T. Lee, S.S. Tseng, R.C. Chang and Y.T.Tsai, “Introduction to the Design and Analysis of Algorithms A Strategic Approach”, Tata McGraw Hill, 2012.
- R3. Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekaran “Fundamentals of Computer Algorithms”, 2<sup>nd</sup> Edition, Universities press, 2008.

### Web References:

- 1. <https://www.coursera.org/specializations/data-structures-algorithms>
- 2. <http://visualalgo.net>

|                                           |                   |                                          |                       |
|-------------------------------------------|-------------------|------------------------------------------|-----------------------|
| <b>Course Code: 24CPL102</b>              |                   | <b>Course Title: Networks Laboratory</b> |                       |
| <b>Course Category: Professional Core</b> |                   | <b>Course Level: Practice</b>            |                       |
| <b>L:T:P(Hours/Week)</b><br><b>0:0:4</b>  | <b>Credits: 2</b> | <b>Total Contact Hours: 60</b>           | <b>Max Marks: 100</b> |

### **Course Objective:**

The course is intended to impart knowledge with hands on experience in designing and implementing networking concepts with quality of services and management techniques.

### **List of Experiments:**

1. Application development using socket programming
2. Performance analysis of transport layer protocols
3. Implementation of congestion control algorithms
4. Design local area network with IP address configuration
5. Design multi-router network and testing using simulation tools
6. Implementation of Routing protocols
7. Design of network virtualization using simulation tools
8. Demonstration of network management using SNMP
9. Implementation of Queuing and Scheduling policies
10. Analysis of LAN traffic using simulation tools

| <b>Course Outcomes</b>                                                                 | <b>Cognitive Level</b> |
|----------------------------------------------------------------------------------------|------------------------|
| At the end of this course, students will be able to:                                   |                        |
| CO1:Design network applications using appropriate socket programming.                  | Create                 |
| CO2:Design IP LAN and WAN network using subnetting and IP address configuration.       | Create                 |
| CO3: Implement network virtualization and management protocols using simulation tools. | Apply                  |
| CO4: Analyze real time network and monitor the performance.                            | Analyze                |

### **Reference Books:**

- R1.James F. Kurose, Keith W. Ross, “Computer Networking – A top down Approach Featuring the Internet”, 8<sup>th</sup> Edition, Pearson Education, 2021.
- R2.Miguel Barreiros, Peter Lundqvist, “QoS Enabled Networks: Tools and Foundations”, 2<sup>nd</sup> Edition, John Wiley & Sons, 2016.

### **Web References:**

1. <https://archive.nptel.ac.in/courses/106/105/106105183/>
2. <https://nptel.ac.in/courses/106106091>

|                                          |                  |                                                                                      |                      |
|------------------------------------------|------------------|--------------------------------------------------------------------------------------|----------------------|
| <b>Course Code: 24SHA101</b>             |                  | <b>Course Title: English for Research Paper Writing (Common to all PG Programme)</b> |                      |
| <b>Course Category: Audit Course</b>     |                  | <b>Course Level: Introductory</b>                                                    |                      |
| <b>L:T:P(Hours/Week)</b><br><b>2:0:0</b> | <b>Credits:-</b> | <b>Total Contact Hours:30</b>                                                        | <b>Max Marks:100</b> |

### Course Objectives:

The course is intended to enhance the language skills concerning research paper writing and to explain the crucial role of technology in enhancing the quality and credibility of research.

### Module I

**15 Hours**

**Foundations of Academic English in Research:** Academic English - Key Language Aspects - Clarity and Precision - Objectivity - Formal Tone - Integrating References. **Effective Writing Style for Research Papers:** Word Order - Sentences and Paragraphs - Link Words for Cohesion - Avoiding Redundancy / Repetition - Breaking up long sentences - Paraphrasing Skills. **Advanced Reading and Research Vocabulary Development:** Critical Reading Strategies - Analysing Research Articles - Identifying Arguments - Evaluating Findings - Formulaic Expressions - Academic Phrase Bank - Discipline-Specific Vocabulary - Commonly Misused Words.

### Module II

**15 Hours**

**Presentation Language Skills:** Written vs. Spoken English - Dynamic Vocabulary for Presentations -Expressive Language for Audience Engagement- Language for Clear and Impactful Slides - Adapting Language Style to Different Audiences. **Grammar Refinement for Research Writing:** Advanced Punctuation Usage- Proper Use of Modifiers - Avoiding Ambiguous Pronoun References - Verb Tense Consistency - Conditional Sentences. **Technology and Language for Research:** Technology and Role of AI in Research Writing - Citations and References - Plagiarism and Ethical Considerations - Tools and Awareness - Fair Practices.

| Course Outcomes                                                                                          | Cognitive Level |
|----------------------------------------------------------------------------------------------------------|-----------------|
| At the end of this course, students will be able to:                                                     |                 |
| CO 1: Enhance their English Language Skills concerning research paper writing.                           | Understand      |
| CO 2: Develop a comprehensive set of linguistic skills essential for academic research.                  | Apply           |
| CO 3: Produce well-structured research papers using a variety of research and presentation technologies. | Apply           |

### Reference Books:

- R1. Craswell, G. 2004. Writing for Academic Success. Sage Publications. Springer, New York.
- R2. Wallwork, Adrian. 2015. English for Academic Research: Grammar, Usage and Style.
- R3. Swales, J. & C. Feak. 2012. Academic Writing for Graduate Students: Essential Skills and Tasks. Michigan University Press.
- R4. English for Writing Research Papers, Springer, New York, 2011.

### Web References:

1. <https://tiramisutes.github.io/images/PDF/English+for+Writing+Research+Papers.pdf>
2. <https://libguides.usc.edu/writingguide/grammar>
3. [https://onlinecourses.swayam2.ac.in/ntr24\\_ed15/preview](https://onlinecourses.swayam2.ac.in/ntr24_ed15/preview)

### Assessment Pattern:

|                                                | Assessment Component     | Co. No. | Marks | Total |
|------------------------------------------------|--------------------------|---------|-------|-------|
| Continuous Comprehensive Evaluation (Internal) | Assignment 1             | 1       | 20    | 100   |
|                                                | Assignment 2             | 2       | 20    |       |
|                                                | Assignment 3             | 3       | 20    |       |
|                                                | MCQ                      | 1,2,3   | 20    |       |
|                                                | Descriptive Pattern Test | 1,2,3   | 20    |       |

Student will be finally awarded with three levels based on the score as follows:

| Marks Scored | Levels  |
|--------------|---------|
| 70% & above  | Good    |
| 30-69 %      | Average |
| < 30 %       | Fair    |

## Syllabus - Semester II

|                                           |                  |                                     |                      |
|-------------------------------------------|------------------|-------------------------------------|----------------------|
| <b>Course Code: 24CPT201</b>              |                  | <b>Course Title: Data Analytics</b> |                      |
| <b>Course Category: Professional Core</b> |                  | <b>Course Level: Practice</b>       |                      |
| <b>L:T:P(Hours/Week)<br/>3:0:0</b>        | <b>Credits:3</b> | <b>Total Contact Hours:45</b>       | <b>Max Marks:100</b> |

### **Course Objectives:**

The course is intended to impart knowledge on various models and algorithms used for the analyzing the given datasets. The course intends to provide in-depth knowledge on the methods used for descriptive and predictive analysis of real time data.

### **Module I**

**22 Hours**

**Descriptive Analytics:** Big Data and Data Science – KDD Process – Descriptive Statistics – Univariate and Multivariate Analysis – Data Quality and Preprocessing – Data Transformation Methods – Clustering Techniques – Distance Measures – K-means – DBSCAN – Agglomerative Hierarchical Clustering Technique – Frequent Pattern Mining – Case Study: Descriptive Analytics on Breast Cancer Dataset.

### **Module II**

**23 Hours**

**Predictive Analytics:** Regression – Classification – Distance-based Learning Algorithms – Probabilistic Classification Algorithms – Search-based Algorithms – Optimization-based Algorithms – Ensemble Learning – Algorithm Bias – Non-binary Classification Tasks – Advanced Data Preparation Techniques for Prediction – Performance Evaluation Techniques – Applications: Text Analytics – Recommender Systems – Social Network Analysis – Case Study: Predictive Analytics on Movie Dataset

| Course Outcomes                                                                                                   | Cognitive Level |
|-------------------------------------------------------------------------------------------------------------------|-----------------|
| At the end of this course, students will be able to:                                                              |                 |
| CO1:Perform exploratory data analysis on the given datasets using similarity based algorithms                     | Apply           |
| CO2:Extract hidden patterns and perform descriptive analysis of dataset using appropriate model                   | Analyze         |
| CO3:Develop Predictive data analytics based solutions for real world problems using inductive learning algorithms | Create          |
| CO4:Build solutions for Text, Web and Social Media problems using suitable data analytic models                   | Create          |

### **Text Book:**

T1. Joao Mendes Moreira, Andre Carvalho, Tomas Horvath, “A General Introduction to Data Analytics”, John Wiley & Sons, 2019

### **Reference Books:**

- R1. John D. Kelleher, Brian Mac Namee, and Aoife D’Arcy, “Fundamentals of Machine Learning for Predictive Data Analytics”, 2<sup>nd</sup> Edition, MIT Press, 2020
- R2. Thomas A. Runkler, “Data Analytics Models and Algorithms for Intelligent Data Analysis”, 3<sup>rd</sup> Edition, Springer, 2020

### **Web References:**

1. <https://archive.nptel.ac.in/courses/110/106/110106072/#>
2. [https://onlinecourses.nptel.ac.in/noc21\\_cs45/preview](https://onlinecourses.nptel.ac.in/noc21_cs45/preview)
3. <https://www.coursera.org/learn/introduction-to-data-analytics>

|                                            |                  |                                       |                      |
|--------------------------------------------|------------------|---------------------------------------|----------------------|
| <b>Course Code: 24CPT202</b>               |                  | <b>Course Title: Machine Learning</b> |                      |
| <b>Course Category: Professional Core</b>  |                  | <b>Course Level: Practice</b>         |                      |
| <b>L:T:P(Hours/Week)</b><br><b>3: 0: 0</b> | <b>Credits:3</b> | <b>Total Contact Hours:45</b>         | <b>Max Marks:100</b> |

### **Course Objective:**

The course is intended to impart knowledge on machine learning, supervised and unsupervised learning techniques.

### **Module I**

**22 Hours**

Machine Learning- History – Definitions – Applications - Advantages, Disadvantages & Challenges -Types of Machine Learning Problems – Mathematical Foundations - Linear Algebra & Analytical Geometry -Probability and Statistics- Discriminative and Generative Models -Linear Regression - Least Squares -Under-fitting / Overfitting -Cross-Validation – Lasso Regression- Classification - Logistic Regression- Gradient Linear Models -Support Vector Machines –Kernel Methods -Instance based Methods - K-Nearest Neighbours - Tree based Methods –Decision Trees –ID3 – CART - Ensemble Methods –Random Forest - Evaluation of Classification Algorithms

### **Module II**

**23 Hours**

Clustering Algorithms: K-Means – Hierarchical Clustering - Cluster Validity - Dimensionality Reduction –Principal Component Analysis – Recommendation Systems - EM algorithm. Reinforcement Learning – Elements -Model based Learning – Temporal Difference Learning- Markov Models – Hidden Markov Model- Deep Learning- Building blocks of Neural Networks– Convolutional Neural Networks (CNN) – Recurrent Neural Networks (RNN).

| <b>Course Outcomes</b>                                                                                                             | <b>Cognitive Level</b> |
|------------------------------------------------------------------------------------------------------------------------------------|------------------------|
| At the end of this course, students will be able to:                                                                               |                        |
| CO1: Design a supervised learning model that can learn and predict output in real time.                                            | Apply                  |
| CO2: Implement and evaluate Probabilistic, Discriminative and Generative algorithms for an application.                            | Analyze                |
| CO3: Apply unsupervised learning techniques on real-world dataset for clustering and dimensionality reduction.                     | Apply                  |
| CO4: Employ neural network and deep learning algorithms to design learning models for text / speech /image processing application. | Create                 |

### **Text Books:**

- T1. Stephen Marsland, "Machine Learning: An Algorithmic Perspective", 2<sup>nd</sup> Edition, CRC press, 2014.
- T2 Ethem Alpaydin, "Introduction to Machine Learning", 2<sup>nd</sup> Edition, MIT Press, 2014.
- T3. Seth Weidman, "Deep Learning from Scratch: Building with Python from First Principles", O'Reilly publication, 2019.

### **Reference Books:**

- R1. S.Sridar, M.Vijayalakshmi , "Machine Learning", Oxford University Press, 2021.
- R2. Josh Patterson and Adam Gibson, "Deep Learning: A Practitioner's Approach", O'Reilly, 2017.

### **Web References:**

1. <https://nptel.ac.in/courses/106106139>
2. <https://www.kaggle.com/kanncaa1/machine-learning-tutorial-for-beginners>
3. <https://www.coursera.org/learn/machine-learning-duke>

|                                           |                  |                                               |                      |
|-------------------------------------------|------------------|-----------------------------------------------|----------------------|
| <b>Course Code: 24CPT203</b>              |                  | <b>Course Title: Modern Operating Systems</b> |                      |
| <b>Course Category: Professional Core</b> |                  | <b>Course Level: Practice</b>                 |                      |
| <b>L:T:P(Hours/Week)</b><br><b>3:0:0</b>  | <b>Credits:3</b> | <b>Total Contact Hours:45</b>                 | <b>Max Marks:100</b> |

### **Course Objectives:**

The course is intended to impart knowledge on demonstrating the design and synchronization issues between processes, resource management techniques for Distributed systems, Failure Recovery and Fault Tolerance. The course also intends to describe the different features of real time and Mobile Operating Systems.

### **Module I**

**23 Hours**

**Architectures of Distributed Systems:** System Architecture Types - Distributed Operating Systems- Issues in Distributed Operating Systems- Communication Primitives Distributed Mutual Exclusion- Distributed Deadlock Detection- Agreement Protocols- Distributed File Systems- Distributed Shared Memory- Distributed Scheduling

### **Module II**

**22 Hours**

**Classification of Failures:** Error recovery – Recovery in concurrent systems – Check pointing and recovery. **Fault tolerance:** Issues – Commit protocols – Voting protocols: Static, Dynamic – Failure resilient processes – Reliable communication. **Real Time Systems:** Introduction – Concepts of Real Time Task Scheduling – Scheduling of Real time tasks in Multiprocessor and Distributed Systems-Handling Resource Sharing. **Mobile OS:** Architecture and SDK Framework –Media Layer –Services Layer –Core OS Layer – File System. **Case Study- iOS:** Features of iOS-Architecture of iOS-iOS Kernel Architecture-Processes and Threads Management-Memory Management-File System in iOS.

| Course Outcomes                                                                                                      | Cognitive Level |
|----------------------------------------------------------------------------------------------------------------------|-----------------|
| At the end of this course, students will be able to:                                                                 |                 |
| CO1: Solve communication and synchronization issues between processes in a distributed environment                   | Apply           |
| CO2: Analyze various resource management techniques for distributed systems.                                         | Analyze         |
| CO3: Design fault-tolerant systems using various failure recovery models and commit protocols in distributed systems | Apply           |
| CO4: Analyze the working principles of Real-Time and Mobile Operating Systems.                                       | Analyze         |

### Text Books:

- T1. Mukesh Singhal, Niranjan G. Shivaratri, "Advanced Concepts in Operating Systems: Distributed, Database, and Multiprocessor Operating Systems", Tata McGraw-Hill, 2011.
- T2. Rajib Mall, "Real-Time Systems: Theory and Practice", Pearson Education India, 2007.

### Reference Books:

- R1. Pradeep K. Sinha, "Distributed Operating Systems: Concepts and Design", PHI Learning, 2012.
- R2. Phillip A. Laplante Seppo J. Ovaska, "Real-Time Systems Design and Analysis -Tools for the Practitioner", 4<sup>th</sup> Edition, John Wiley & Sons Publication, 2012
- R3. John Ray, "iOS 9 Application Development in 24 Hours", Sams Teach Yourself, 2019.

### Web References:

1. <https://nptel.ac.in/courses/106106168/>
2. <https://archive.nptel.ac.in/courses/106/105/106105229/>
3. <https://developer.apple.com/>

|                                           |                   |                                                                     |                       |
|-------------------------------------------|-------------------|---------------------------------------------------------------------|-----------------------|
| <b>Course Code: 24CPL201</b>              |                   | <b>Course Title: Data Analytics and Machine Learning Laboratory</b> |                       |
| <b>Course Category: Professional Core</b> |                   | <b>Course Level: Practice</b>                                       |                       |
| <b>L:T:P(Hours/Week)</b><br><b>0:0:4</b>  | <b>Credits: 2</b> | <b>Total Contact Hours: 60</b>                                      | <b>Max Marks: 100</b> |

### **Course Objective:**

The course is intended to impart knowledge with hands on experience in designing and implementing data analytics using Machine Learning techniques for providing solutions to real world problems.

### **List of Experiments:**

1. Implement data processing techniques and data analytic functions.
2. Perform exploratory data analysis with simple visualizations using real time data.
3. Cluster the given data using various models and evaluate the performance.
4. Construct linear regression models using the given dataset.
5. Perform Text Analysis operations with the given dataset.
6. Demonstrate sentiment analysis process with the sample dataset.
7. Build a machine learning model to solve real-world problems using kernel machines.
8. Implement Dimensionality reduction technique.
9. Design a Convolutional Network to identify handwriting character recognition.
10. Develop a speech processing application using Recurrent Neural Networks.

Identified Tools: Python, R tool, Open Web Analytics, Microsoft Power BI Desktop, Apache Spark

| Course Outcomes                                                                                                     | Cognitive Level |
|---------------------------------------------------------------------------------------------------------------------|-----------------|
| At the end of this course, students will be able to:                                                                |                 |
| CO1: Demonstrate the data pre-processing and data analysis concepts for the given dataset and visualize the results | Apply           |
| CO2: Identify the patterns in the given dataset and organize them based on similarity                               | Apply           |
| CO3: Develop prediction based algorithms and evaluate their performance                                             | Analyze         |
| CO4: Build efficient Machine Learning models to provide data analytic solutions for real time problems.             | Create          |

### Reference Books:

- R1. Avinash Navlani, Armando Fandango, Ivan Idris, "Python Data Analysis: Perform Data Collection, Data Processing, Wrangling, Visualization, and Model Building Using Python", 3<sup>rd</sup> Edition, Packt Publishing, 2021.
- R2. Sayan Mukhopadhyay, "Advanced Data Analytics Using Python With Machine Learning, Deep Learning and NLP Examples", Apress, 2018.
- R3. Abdulhamit Subasi, "Practical Machine Learning for Data Analysis Using Python", Elsevier Science, 2020.

### Web References:

1. <https://ifacet.iitk.ac.in/professional-certificate-course-in-data-analytics/>
2. <https://www.pluralsight.com/courses/data-analytics-hands-on>

|                                           |                   |                                             |                       |
|-------------------------------------------|-------------------|---------------------------------------------|-----------------------|
| <b>Course Code: 24CPL202</b>              |                   | <b>Course Title: Research Paper Seminar</b> |                       |
| <b>Course Category: Professional Core</b> |                   | <b>Course Level: Practice</b>               |                       |
| <b>L:T:P(Hours/Week)</b><br><b>0:0:2</b>  | <b>Credits: 1</b> | <b>Total Contact Hours: 30</b>              | <b>Max Marks: 100</b> |

### **Course Objective:**

The course is intended to develop critical analysis, presentation, and research communication skills by engaging students in the study, review, and presentation of contemporary research papers in Computer Science and Engineering domain.

### **Assessment Methodology:**

1. Internal Assessment: 75 Marks
  - Three Reviews – Each carrying 25 marks ( $3 \times 25 = 75$  marks)
2. Final Review: 25 marks

| <b>Course Outcomes</b>                                                                                                                                    | <b>Cognitive Level</b> |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|
| At the end of this course, students will be able to:                                                                                                      |                        |
| CO1:Analyze research papers and identify key contributions, methodologies, and limitations in the context of current advancements of the research domain. | Analyze                |
| CO2: Communicate the technical content, demonstrating clarity of thought, depth of understanding, and engage in scholarly discussion.                     | Apply                  |



|                                            |                  |                                                                                            |                      |
|--------------------------------------------|------------------|--------------------------------------------------------------------------------------------|----------------------|
| <b>Course Code: 24SHA201</b>               |                  | <b>Course Title: Teaching and Learning in Engineering</b><br>(Common to all PG Programmes) |                      |
| <b>Course Category: Audit Course</b>       |                  | <b>Course Level: Introductory</b>                                                          |                      |
| <b>L:T:P(Hours/Week)</b><br><b>0: 0: 4</b> | <b>Credits:-</b> | <b>Total Contact Hours:30</b>                                                              | <b>Max Marks:100</b> |

### **Course Objective:**

The course is intended to impart knowledge on an outcome-based approach, employing active learning methods in lecture/practical/tutorial sessions. Assessments will be conducted using rubrics, focusing on higher-order thinking skills.

### **Module I**

**15 Hours**

#### **Outcome Based Approach**

Outcome based Education- Need & Approach- Washington accord- Graduate attributes- Learning outcomes –Blooms Taxonomy.

#### **Active Learning Methods**

Design and Delivery plan for lectures/practical/tutorial sessions-Need for Active learning methods-Active learning strategies- Benefits of Active learning Methods

### **Module II**

**15 Hours**

#### **Assessments**

Assessments- types of assessments-need for rubrics, Types of rubrics- Assessment using rubrics.

| <b>Course Outcomes</b>                                                         | <b>Cognitive Level</b> |
|--------------------------------------------------------------------------------|------------------------|
| At the end of this course, students will be able to:                           |                        |
| CO1:Use outcome based approach in teaching courses in engineering Programmes.  | Apply                  |
| CO2:Conduct lecture/practical/tutorial sessions using active learning methods. | Apply                  |
| CO3: Conduct higher order assessments by using rubrics.                        | Apply                  |

### **Reference Books:**

- R1. William G. Spady and Francis Aldrine A. Uy, "Outcome-Based Education: Critical Issues and Answers", Maxcor Publishing House, 2014
- R2. Dr. William G. Spady, WajidHussain, Joan Largo, Dr. Francis Uy, "Beyond Outcomes Accreditation: Exploring the Power of 'Real' OBE Practices", 2018
- R3. Richard M. Felder, Rebecca Brent, "Teaching and Learning STEM: A Practical Guide", John Wiley & Sons, 2016

### Syllabus - Semester III

|                                           |                    |                                 |                       |
|-------------------------------------------|--------------------|---------------------------------|-----------------------|
| <b>Course Code: 24CPP301</b>              |                    | <b>Course Title: Project I</b>  |                       |
| <b>Course Category: Project</b>           |                    | <b>Course Level: Mastery</b>    |                       |
| <b>L:T:P(Hours/Week)</b><br><b>0:0:20</b> | <b>Credits: 10</b> | <b>Total Contact Hours: 150</b> | <b>Max Marks: 200</b> |

#### **Course Objective:**

The objective of this course is to provide students with the opportunity to initiate independent research by identifying a relevant problem statement, conducting an in-depth literature review, and understanding existing methodologies. The course aims to develop analytical, technical, and problem-solving skills through the implementation and evaluation of a base system, thereby preparing students for the subsequent phases of their research project.

| <b>Course Outcomes</b>                                                                                                                                            | <b>Cognitive Level</b> |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|
| At the end of this course, students will be able to:                                                                                                              |                        |
| CO1: Identify a research problem, review relevant literature, and formulate clear research objectives aligned with current trends and technological advancements. | Analyze                |
| CO2: Implement and evaluate an existing system or methodology, analyze its performance, and identify potential gaps or areas for further research.                | Evaluate               |

### **Syllabus - Semester IV**

|                                     |                    |                                 |                       |
|-------------------------------------|--------------------|---------------------------------|-----------------------|
| <b>Course Code: 24CPP401</b>        |                    | <b>Course Title: Project II</b> |                       |
| <b>Course Category: Project</b>     |                    | <b>Course Level: Mastery</b>    |                       |
| <b>L:T:P(Hours/Week)<br/>0:0:32</b> | <b>Credits: 16</b> | <b>Total Contact Hours: 240</b> | <b>Max Marks: 400</b> |

#### **Course Objective:**

The objective of this course is to enable students to design, develop, and implement innovative solutions to the identified problem, analyze results using appropriate methodologies, and effectively communicate their findings through technical documentation and presentations, demonstrating readiness for professional practice or further research.

| <b>Course Outcomes</b>                                                                                                                                     | <b>Cognitive Level</b> |
|------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|
| At the end of this course, students will be able to:                                                                                                       |                        |
| CO1: Develop comprehensive solutions to defined engineering problem using appropriate tools, technologies, and methodologies.                              | Create                 |
| CO2: Analyze, interpret, validate results, and effectively communicate the research outcomes through well-structured documentation and oral presentations. | Evaluate               |

## List of Professional Electives

|                                               |                  |                                                     |                      |
|-----------------------------------------------|------------------|-----------------------------------------------------|----------------------|
| <b>Course Code: 24CPE001</b>                  |                  | <b>Course Title: Advanced Computer Architecture</b> |                      |
| <b>Course Category: Professional Elective</b> |                  | <b>Course Level: Mastery</b>                        |                      |
| <b>L:T:P(Hours/Week)<br/>3:0:0</b>            | <b>Credits:3</b> | <b>Total Contact Hours:45</b>                       | <b>Max Marks:100</b> |

### Course Objectives:

The course is intended to impart knowledge on principles and design of Instruction Set Architectures, Memory Hierarchy and aspects related to various levels of parallelism. The course also provides awareness on the working of Domain Specific Architectures.

|                 |                                                        |                 |
|-----------------|--------------------------------------------------------|-----------------|
| <b>Module I</b> | <b>Memory Hierarchy, Instruction Level Parallelism</b> | <b>23 Hours</b> |
|-----------------|--------------------------------------------------------|-----------------|

Fundamentals of Quantitative Design and Analysis-Memory Hierarchy Design: Optimizations of Cache Performance – Memory Technology and Optimizations – Protection: Virtual Memory and Virtual Machines – Design of Memory Hierarchies - Instruction Level Parallelism and its Exploitation – Concepts and Challenges –Exposing ILP - Advanced Branch Prediction - Dynamic Scheduling - Hardware-Based Speculation - Exploiting ILP - Instruction Delivery and Speculation - Limitations of ILP -Cross-Cutting Issues.

|                  |                                                |                 |
|------------------|------------------------------------------------|-----------------|
| <b>Module II</b> | <b>Data level and Thread Level Parallelism</b> | <b>22 Hours</b> |
|------------------|------------------------------------------------|-----------------|

**Data level Parallelism** – Vector Architecture- SIMD Instruction Set Extensions for Multimedia- Graphics Processing Units- Detecting and Enhancing Loop-Level Parallelism- Cross-cutting issues

**Thread level parallelism** - Centralized Shared Memory Architecture- Performance of Symmetric- Shared Memory Multiprocessors- Distributed Shared Memory and Directory-Bases Coherence- Basics of Synchronization- Models of Memory Consistency –Cross-cutting issues.

**Case Study:** Domain-specific architectures: Deep Neural Networks-Google's Tensor Processing Unit.

| Course Outcomes                                                                                                         | Cognitive Level |
|-------------------------------------------------------------------------------------------------------------------------|-----------------|
| At the end of this course, students will be able to:                                                                    |                 |
| CO1:Analyze the design and functioning of memory hierarchies, including caches, main memory, and virtual memory systems | Analyze         |
| CO2:Analyze structural, data and control hazards and exploit the various aspects of Instruction level parallelism       | Analyze         |
| CO3:Predict the challenges of realizing data and thread level parallelism for performance advancement                   | Apply           |
| CO4:Analyze the working principles of domain specific architectures to accelerate data processing                       | Analyze         |

#### **Text Book:**

T1. John L. Hennessey and David A. Patterson, “Computer Architecture – A Quantitative Approach”, 6<sup>th</sup> Edition, Morgan Kaufmann, 2019.

#### **Reference Books:**

R1. Richard Y. Kain, “Advanced Computer Architecture - A Systems Design Approach”, Pearson, 2015.

R2. Kai Hwang, Naresh Jotwani, “Advanced Computer Architecture”, 3<sup>rd</sup> Edition, Tata McGraw-Hill, 2017

#### **Web References:**

1. <https://nptel.ac.in/courses/106105033/>

2. <https://archive.nptel.ac.in/courses/106/103/106103206/>

|                                               |                  |                                         |                      |
|-----------------------------------------------|------------------|-----------------------------------------|----------------------|
| <b>Course Code: 24CPE002</b>                  |                  | <b>Course Title: Advanced Databases</b> |                      |
| <b>Course Category: Professional Elective</b> |                  | <b>Course Level: Mastery</b>            |                      |
| <b>L:T:P(Hours/Week)</b><br><b>3:0:0</b>      | <b>Credits:3</b> | <b>Total Contact Hours:45</b>           | <b>Max Marks:100</b> |

### **Course Objectives:**

The course is intended to impart knowledge on database management systems. The course intends to provide exposure on advanced concepts such as parallel & distributed systems, object oriented, Spatial and Temporal databases.

### **Module I**

**23 Hours**

**Relational Model:** ER and Relational Data Model – Relational Algebra – Structured Query Language – Database Normalization – Concurrency control mechanisms – Deadlock Handling. **Parallel and distributed databases:** Centralized and Client-Server architectures – Parallel and Distributed systems – Distributed transactions – Locking and Commit protocols – Distributed Concurrency control – Distributed Query Processing - Parallel Databases. Database Recovery: Failures – Recovery techniques – Advanced Database Security.

### **Module II**

**22 Hours**

**Object oriented Databases and XML:** OODBMS – XML Data Model – DTD – XML Schema – XML Querying – Web Databases. **Spatial and Temporal Databases:** Spatial Data Types and Models – Spatial Operators and Spatial Queries – Spatial Data Indexing – Temporal Database forms and Architecture – Temporal Data Model – Querying Temporal databases – Graph Databases. **Performance Optimization:** Profiling and Performance Monitoring – Query Optimization – Indexing Strategies.

| Course Outcomes                                                                                   | Cognitive Level |
|---------------------------------------------------------------------------------------------------|-----------------|
| At the end of this course, students will be able to:                                              |                 |
| CO1: Implement parallel and distributed database management concepts for enterprise applications. | Apply           |
| CO2: Design normalized relational database model for real time applications.                      | Create          |
| CO3: Apply advanced database management technique suitable for spatial and temporal applications. | Apply           |
| CO4: Enhance the performance of database systems using optimization techniques.                   | Apply           |

### Text Books:

- T1. Abraham Silberschatz, Henry F. Korth, S. Sudarshan, "Database System Concepts", 7<sup>th</sup> Edition, McGraw-Hill, 2019
- T2. Ramez Elmasri, Shamkant B. Navathe, "Fundamentals of Database Systems", 7<sup>th</sup> Edition, Pearson Education, 2017.

### Reference Books:

- R1. Ian Robinson, Jim Webber, Emil Eifrem, "Graph Databases", O'Reilly, 2013
- R2. "Mastering Database Performance Optimization and Scalability", Cybellium, 2023

### Web References:

1. <https://nptel.ac.in/courses/106105175>
2. <https://opencourse.inf.ed.ac.uk/adbs>



| <b>Course Outcomes</b>                                                                                   | <b>Cognitive Level</b> |
|----------------------------------------------------------------------------------------------------------|------------------------|
| At the end of this course, students will be able to:                                                     |                        |
| CO1:Analyze code to determine information necessary for optimization.                                    | Analyze                |
| CO2:Apply common code optimization techniques to enhance the performance of software.                    | Apply                  |
| CO3:Optimize code for specific target architectures by utilizing advanced features and instruction sets. | Apply                  |
| CO4:Assess the impact of code optimization techniques on code performance and resource utilization.      | Evaluate               |

### **Text Books:**

- T1. Steven. S. Muchnick, “Advanced Compiler Design and Implementation”, Morgan Kaufman, 1997.
- T2. Randy Allen, Ken Kennedy, “Optimizing Compilers for Modern Architectures: A Dependence based Approach”, Morgan Kaufman, 2005.

### **Reference Books:**

- R1. Alfred V. Aho, Monica S. Lam, Ravi Sethi, Jeffrey D. Ullman, “Compilers: Principles, Techniques, and Tools”, 2<sup>nd</sup> Edition, Pearson Education, 2014.
- R2. Y. N. Srikant, Priti Shankar, “The Compiler Design Handbook – Optimizations and Machine Code Generation”, 2<sup>nd</sup> Edition, CRC Press, 2007.

### **Web References:**

- 1. <https://nptel.ac.in/courses/106108052>
- 2. <https://www.cs.cornell.edu/courses/cs6120/2020fa/self-guided/>

|                                               |                  |                                                          |                       |
|-----------------------------------------------|------------------|----------------------------------------------------------|-----------------------|
| <b>Course Code: 24CPE004</b>                  |                  | <b>Course Title: Digital Media Processing Techniques</b> |                       |
| <b>Course Category: Professional Elective</b> |                  | <b>Course Level: Mastery</b>                             |                       |
| <b>L:T:P (Hours/Week)</b><br><b>3:0:0</b>     | <b>Credits:3</b> | <b>Total Contact Hours: 45</b>                           | <b>Max Marks: 100</b> |

### **Course Objective:**

The course is intended to impart knowledge on Image transforms, Enhancement, Compression, Segmentation, Color image and video processing.

### **Module I Image Transforms, Enhancement and Restoration**

**23 Hours**

**Introduction:** Steps in Digital Image processing – Elements of visual Perception – Image Sensing and Acquisition-Image Sampling and Quantization-Pixel relationships. **Image Transforms:** Discrete and Fast Fourier Transform and Discrete Cosine Transform-Wavelet Transform and Multi-resolution Processing. **Image Enhancement and Restoration:** Spatial Domain – Gray-level Transformations Histogram Processing – Spatial Filtering – Smoothing and Sharpening - Frequency Domain: Filtering in Frequency Domain – Smoothing and Sharpening filters – Homomorphic Filtering, Noise models, Constrained and Unconstrained restoration models. **Image Compression:** Redundancies, Image compression standards, Lossy and Loss-less predictive coding

### **Module II Color image and Video Processing , Segmentation**

**22 Hours**

**Color Image Processing:** Color fundamentals – Color models. **Image Segmentation:** Detection of isolated points, Line, edge linking and boundary – Thresholding: global and adaptive – Region based segmentation. **Feature Extraction:** Boundary feature descriptors - Region feature descriptors - Principal Component as feature descriptors - Whole image features: Harris-Stephens Corner detector - Scale Invariant Feature Transform (SIFT). **Video Processing:** Digital Video and its applications – 2D Apparent Motion Models and its Estimation– Video Segmentation: Change detection, Motion segmentation and tracking— Video Compression standards: MPEG-1, MPEG-2 and H.26X

| <b>Course Outcomes</b>                                                                                              | <b>Cognitive Level</b> |
|---------------------------------------------------------------------------------------------------------------------|------------------------|
| At the end of this course, students will be able to:                                                                |                        |
| CO1:Apply appropriate image processing methods to solve real world problems                                         | Apply                  |
| CO2:Critically analyze different approaches to image processing applications.                                       | Analyze                |
| CO3:Design and implement algorithms for image processing applications                                               | Create                 |
| CO4:Design appropriate motion models and segmentation for video processing in implementing video based applications | Create                 |

### **Text Books:**

- T1. R.C. Gonzalez and R.E. Woods, "Digital Image Processing", 4<sup>th</sup> Edition, Pearson Education, 2018.
- T2. Murat Tekalp , "Digital Video Processing", 2<sup>nd</sup> Edition, Prentice Hall, 2015.

### **Reference Books:**

- R1. Anil K Jain, "Fundamentals of Digital Image Processing", Prentice Hall of India 2003.
- R2. Milan Sonka , "Digital Image Processing and Computer Vision", 2<sup>nd</sup> Edition, Thomson publication, 2007.

### **Web References:**

1. <https://www.coursera.org/learn/digital>
2. <https://archive.nptel.ac.in/courses/117/105/117105135/>

|                                               |                  |                                     |                       |
|-----------------------------------------------|------------------|-------------------------------------|-----------------------|
| <b>Course Code: 24CPE005</b>                  |                  | <b>Course Title: Soft Computing</b> |                       |
| <b>Course Category: Professional Elective</b> |                  | <b>Course Level: Mastery</b>        |                       |
| <b>L:T:P (Hours/Week)</b><br><b>3:0:0</b>     | <b>Credits:3</b> | <b>Total Contact Hours: 45</b>      | <b>Max Marks: 100</b> |

### **Course Objective:**

The course is intended to impart knowledge on Fuzzy logic, Knowledge based Systems, Neural networks and optimization techniques for various predictive models

### **Module I Intelligent System, Fuzzy Logic and Supervised Learning Network 23 Hours**

Intelligent system – Knowledge based system - Expert systems – Knowledge representation processing – Soft computing.

**Fuzzy logic system:** Fundamentals - Fuzzy set - Fuzzy logic operations – Fuzzy resolution - Fuzzy relations - Composition and inference: Projection, Cylindrical Extension, Join, Composition, Composition rule of inference – Fuzzy Decision Making – Fuzzy Logic Control Architecture.

**Neural Networks:** Machine Learning Basics - Activation functions - Supervised Learning Neural Networks: Perceptron Network, Adaline, Back propagation Network.

### **Module II Unsupervised Learning Network and Evolutionary Computing 22 Hours**

**Unsupervised Learning Neural Networks:** Maxnet – Kohonen - Self-Organizing Feature Maps - Adaptive Resonance Theory Network – Reinforcement Learning.

**Evolutionary Computing:** Origins – Evolutionary Algorithm - Components of Evolutionary Algorithms – Representation – Mutation - Recombination – Fitness, Selection and Population Management – Popular Evolutionary Algorithm.

**Genetic algorithm and Optimization** – Genetic algorithm operators – Integration of genetic algorithm with Neural network & Fuzzy logic –ES Applications.

| <b>Course Outcomes</b>                                                                                  | <b>Cognitive Level</b> |
|---------------------------------------------------------------------------------------------------------|------------------------|
| At the end of this course, students will be able to:                                                    |                        |
| CO1:Use knowledge and rules for solving real world problems.                                            | Apply                  |
| CO2:Analyze various fuzzy reasoning approaches for decision making effectively in engineering problems. | Analyze                |
| CO3:Choose appropriate neural network architectures to encounter the challenges in the world.           | Analyze                |
| CO4:Design evolutionary algorithm for optimize problems                                                 | Create                 |

### **Text Books:**

- T1. Fakhreddine O. Karray, "Soft Computing and Intelligent Systems Design: Theory, Tools and Applications", Pearson Education India, 2004.
- T2. S. N. Sivanandam, S. N. Deepa, "Principles of Soft Computing", 3<sup>rd</sup> Edition, John Wiley & Sons, New Delhi, 2019.
- T3. A.E. Eiben J.E. Smith, "Introduction to Evolutionary Computing", Natural Computing Series, Springer, New York, 2015.

### **Reference Books:**

- R1. Jyh-Shing Roger Jang, Chuen-Tsai Sun, Eiji Mizutani, "Neuro-Fuzzy and Soft Computing", Prentice-Hall of India, 2015.
- R2. Timothy J. Ross, "Fuzzy Logic with Engineering Applications", 4<sup>th</sup> Edition, Wiley, 2016.
- R3. Simon Haykin, "Neural Networks and Learning Machines", 3<sup>rd</sup> Edition, Prentice Hall, 2009.

### **Web References:**

- 1. <https://archive.nptel.ac.in/courses/106/105/106105173/>
- 2. <https://ocw.mit.edu/courses/brain-and-cognitive-sciences/9-641j-introduction-to-neural-networks-spring-2005/>
- 3. <https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-034-artificial-intelligence-fall-2010/lecture-videos/lecture-13-learning-genetic-algorithms/>

|                                               |                   |                                              |                       |
|-----------------------------------------------|-------------------|----------------------------------------------|-----------------------|
| <b>Course Code: 24CPE006</b>                  |                   | <b>Course Title: Cloud Computing and IoT</b> |                       |
| <b>Course Category: Professional Elective</b> |                   | <b>Course Level: Mastery</b>                 |                       |
| <b>L:T:P(Hours/Week)</b><br><b>3: 0: 0</b>    | <b>Credits: 3</b> | <b>Total Contact Hours: 45</b>               | <b>Max Marks: 100</b> |

### **Course Objectives:**

The course is intended to impart the knowledge of applying Cloud Computing and IoT on diverse applications.

## **Module I**

### **CLOUD COMPUTING**

**23 Hours**

**Understanding Cloud Computing:** Origins and influences-Basic concepts-Goals and Benefits-Roles and Boundaries-Cloud Characteristics- Cloud Delivery Models-Cloud Deployment Models. **Cloud –Enabling Technology:** Cloud Data Center Technology-Multitenant Technology-Service Technology and Service APIs. **Cloud Computing Mechanisms:** Virtual Server-Hypervisor-Cloud Storage Device-Cloud Usage Monitor-Resource Replication-Ready-Made Environment. **Cloud Security Mechanisms:** Security Terminology-Cloud Based Security Groups-Firewall-Virtual Private Network-Biometric Scanner-IDS-Data Backup and Recovery System-Traffic Monitor. **Cloud Management Mechanisms:** Remote Administration system-Resource Management System-SLA Management System-Billing Management System. **Cloud Computing Architecture:** Resource Pooling Architecture-Dynamic Scalability Architecture-Hypervisor Clustering Architecture-Resilient Disaster Recovery Architecture-Virtual private Cloud Architecture-Cloud Usage Cost Metrics-Virtualization and Containerization-Service Quality Metrics.

## **Module II**

### **INTERNET OF THINGS**

**22 Hours**

**INTRODUCTION:** Genesis of IoT- Digitization-Impact-Convergence of IT and IoT- IoT Challenges- Network Architecture and Design- Comparing IoT Architectures - Core IoT Functional Stack-Data Management. **IoT NETWORKS AND PROTOCOLS:** Sensors-Actuators-Smart Objects-Sensor Networks-Connecting Smart Objects-Communication Criteria- IoT Access Technologies- IoT Network Layer-Business care for IP-Optimizing IP for IoT-Profiles and Compliances-Application protocols for IoT-Transport Layer-IoT Application Transport Methods-Securing IoT **APPLICATION:** Manufacturing-Smart and Connected Cities-Transportation-Mining-Public Safety.

| Course Outcomes                                                                                            | Cognitive Level |
|------------------------------------------------------------------------------------------------------------|-----------------|
| At the end of this course, students will be able to:                                                       |                 |
| <b>CO1:</b> Apply cloud computing technology for computing resources to solve real time problems.          | Apply           |
| <b>CO2:</b> Choose the appropriate architecture for resource provisioning to solve performance issues.     | Apply           |
| <b>CO3:</b> Create different connectivity technologies for IoT to arrive at suitable conclusions.          | Create          |
| <b>CO4:</b> Evaluate control measures to offer appropriate solutions for IoT related Industry applications | Evaluate        |

### Text Books:

- T1.Thomas Erl, Zaigham Mahood, Ricardo Puttini, “Cloud Computing, Concept, Technology & Architecture”, Pearson Education, 2024.
- T2.David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, “IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things”, Cisco Press, 2017.

### Reference Books:

- R1.Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi, “Mastering Cloud Computing”, Tata McGraw-Hill, 2013.
- R2.Toby Velte, Anthony Velte, Robert C. Elsenpeter, “Cloud Computing, A Practical Approach”, Tata McGraw-Hill Edition, 2010.
- R3.Olivier Hersent, David Boswarthick, Omar Elloum, “The Internet of Things – Key applications and Protocols”, Wiley, 2012.
- R4.Michael Miller, “The Internet of Things”, Pearson Education, 2015.

### Web References:

1. <https://nptel.ac.in/courses/106105167>
2. <https://www.udemy.com/topic/cloud-computing>
3. <https://nptel.ac.in/courses/10610566>
4. <https://www.coursera.org/learn/iot?specialization=iot>

|                                               |                  |                                                      |                       |
|-----------------------------------------------|------------------|------------------------------------------------------|-----------------------|
| <b>Course Code: 24CPE007</b>                  |                  | <b>Course Title: GPU Architectures and Computing</b> |                       |
| <b>Course Category: Professional Elective</b> |                  | <b>Course Level: Mastery</b>                         |                       |
| <b>L:T:P (Hours/Week)</b><br><b>3:0:0</b>     | <b>Credits:3</b> | <b>Total Contact Hours: 45</b>                       | <b>Max Marks: 100</b> |

### **Course Objective:**

The course is intended to impart knowledge on GPU architectures and development of programming models for GPU processors.

### **Module I GPU architecture, Algorithms**

**23 Hours**

**GPU Architecture:** Evolution of GPU Architectures- Understanding Parallelism with GPU- CUDA Hardware Overview- Grids, Blocks Threads- Memory Handling with CUDA: Shared Memory, Global Memory, Constant Memory and Texture Memory.  
**Algorithms on GPU:** Parallel Patterns: Convolution-Prefix Sum – Sparse Matrix – Vector Multiplication

### **Module II CUDA Programming, OpenCL**

**22 Hours**

**CUDA Programming:** Multi-CPU and Multi-GPU Solutions - Optimizing CUDA Applications: Problem Decomposition-Memory Considerations- Transfers-Thread Usage-Resource Contentions. **Programming Issues:** CUDA Error Handling -Parallel Programming Issues-Algorithmic Issues-Finding and Avoiding Errors. **OpenCL Basics:** OpenCL Standard - Kernels - Host Device Interaction- Execution Environment- Memory Model- Basic OpenCL Examples.

| <b>Course Outcomes</b>                                                                                          | <b>Cognitive Level</b> |
|-----------------------------------------------------------------------------------------------------------------|------------------------|
| At the end of this course, students will be able to:                                                            |                        |
| CO1:Analyze efficient parallel programming patterns to provide efficient solutions for real world applications. | Analyze                |
| CO2:Design optimized algorithms for common GPU application kernels                                              | Apply                  |
| CO3:Analyze CUDA code using suitable tools and techniques to enhance application performance.                   | Analyze                |
| CO4:Develop programming models that leverage the parallel compute engine in GPUs.                               | Create                 |

### **Text Books:**

- T1.Shane Cook, “CUDA Programming: A Developer’s Guide to Parallel Computing with GPUs”, Morgan Kaufman, 2013
- T2.David R Kaeli , Perhaad Mistry, Dana Schaa , Dong Ping Zhang ,”Heterogeneous Computing with OpenCL 2.0” , 3<sup>rd</sup> Edition, Morgan Kaufman, 2015
- T3.David B. Kirk and Wen-mei W. Hwu ,“Programming Massively Parallel Processors A Hands-on Approach,” 2<sup>nd</sup> Edition, Morgan Kaufman, 2016

### **Reference Books:**

- R1.Nicholas Wilt, “CUDA Handbook: A Comprehensive Guide to GPU Programming”, Addison Wesley, 2013
- R2.Jasan Sanders, Edward Kandrot, “CUDA by Example: An Introduction to General Purpose GPU Programming”, Addison Wesley, 2011

### **Web References:**

1. <https://developer.nvidia.com/language-solutions>
2. <https://www.khronos.org/opencl/>

|                                               |                  |                                            |                       |
|-----------------------------------------------|------------------|--------------------------------------------|-----------------------|
| <b>Course Code: 24CPE008</b>                  |                  | <b>Course Title: Security In Computing</b> |                       |
| <b>Course Category: Professional Elective</b> |                  | <b>Course Level: Mastery</b>               |                       |
| <b>L:T:P(Hours/Week)</b><br><b>3:0:0</b>      | <b>Credits:3</b> | <b>Total Contact Hours: 45</b>             | <b>Max Marks: 100</b> |

### **Course Objectives:**

The course is designed to impart knowledge on computer security fundamentals and cryptographic techniques. The course is also intended to address the real-world security challenges in database and networks .

## **Module I      Symmetric and Asymmetric Ciphers**

**22   Hours**

**Symmetric Ciphers:** Introduction – Security Attacks- Security Services – Security Mechanisms- Classical Encryption Techniques: Substitution Techniques, Transposition Techniques – Data Encryption Standard – Advanced Encryption Standard. **Asymmetric Ciphers:** Mathematical Concepts: Modular Arithmetic, Fermat's and Euler's Theorem, Chinese Remainder Theorem– Public Key Cryptography – RSA Algorithm - Diffie-Hellman Key Exchange – Elliptic Curve Cryptography – Message Authentication and Hash Function: Authentication Requirements- Authentication Functions- Message Authentication Codes – Two Simple Hash Functions- Secure Hash Algorithm (SHA-1).

## **Module II      Database and Network Security**

**23   Hours**

**Digital Threats:** Malware: Viruses, Trojan Horses, Worms and Malicious Code, Unintentional(Non-malicious) Programming Oversights: Buffer Overflow, Off-by-One Error - Counter Measures for Users and Developers. **Database and Data Mining Security:** Database Security Requirements – Reliability and Integrity – Sensitive Data-Security in Data Mining and Big Data. **Security in Networks:** Threats to Network Communications-Wireless Network security – Firewalls. **Legal Issues and Ethics:** Protecting programs and Data - Information and the Law – Rights of Employees and Employers- Computer Crime - Ethical Issues in Computer Security

| <b>Course Outcomes</b>                                                                                      | <b>Cognitive Level</b> |
|-------------------------------------------------------------------------------------------------------------|------------------------|
| At the end of this course, students will be able to:                                                        |                        |
| CO1: Utilize various encryption techniques to enhance security in real-world scenarios                      | Apply                  |
| CO2: Design and implement secure authentication mechanisms and encryption schemes to protect sensitive data | Apply                  |
| CO3: Analyze vulnerabilities within computing systems and devise effective security solutions               | Analyze                |
| CO4: Develop solutions to protect organizations and people from cyber-crime.                                | Create                 |

### **Text Books:**

- T1. William Stallings, "Cryptography and Network Security", 8<sup>th</sup> Edition, Pearson Education, 2020
- T2. Charles P. Pfleeger, Shari Lawrence Pfleeger, "Security in Computing", 5<sup>th</sup> Edition, Prentice Hall, 2018

### **Reference Books:**

- R1. Behrouz A. Forozan and Debdeep Mukhopadhyay, "Cryptography And Network Security", 3<sup>rd</sup> Edition, Tata McGraw Hill, 2015
- R2. Bernard L. Menezes, "Network Security and Cryptography", Cengage Learning India, 2010
- R3. Marjie T. Britz, "Computer Forensics and Cyber Crime-An Introduction", 3<sup>rd</sup> Edition, Pearson Education, 2013.

### **Web References:**

- 1. [https://onlinecourses.nptel.ac.in/noc22\\_cs90/preview](https://onlinecourses.nptel.ac.in/noc22_cs90/preview)
- 2. <https://archive.nptel.ac.in/courses/106/105/106105031/>
- 3. <http://williamstallings.com/Cryptography/Crypto8e-Student/>

|                                               |                   |                                                  |                       |
|-----------------------------------------------|-------------------|--------------------------------------------------|-----------------------|
| <b>Course Code: 24CPE009</b>                  |                   | <b>Course Title: Natural Language Processing</b> |                       |
| <b>Course Category: Professional Elective</b> |                   | <b>Course Level: Mastery</b>                     |                       |
| <b>L:T:P (Hours/Week)</b><br><b>3: 0: 0</b>   | <b>Credits: 3</b> | <b>Total Contact Hours: 45</b>                   | <b>Max Marks: 100</b> |

### **Course Objectives:**

The course is intended to impart knowledge on implementing Natural Language Processing functionalities and language models. The course will enable learners to develop simple NLP applications.

### **Module I – NLP Functionalities**

**23 Hours**

Regular Expressions – Text Normalization - Minimum Edit Distance; **N-gram Language Models:** N-grams – Evaluating Language Models – Generalization– Smoothing; **Naive Bayes and Sentiment Classification:** Naive Bayes Classifiers - Other text classification tasks - Naive Bayes as a Language Model - Evaluation: Precision, Recall, F-measure; **Vector Semantics:** Lexical Semantics - Vector Semantics - Words and Vectors - Cosine for measuring similarity- TF-IDF; Sequence Labeling: English Word Classes - Part-of-Speech Tagging - Named Entities and Named Entity Tagging - HMM POS Tagging - Evaluation of NER; **Constituency Grammars:** Constituency - Context-Free Grammars - Grammar Rules for English – Treebanks - Grammar Equivalence and Normal Form - Lexicalized Grammars

### **Module II – Language Models**

**22 Hours**

Feed-Forward Neural Networks - Neural Language Models - Deep Learning Architectures - Recurrent Neural Networks - LSTMs and GRUs; **Constituency Parsing:** CKY Parsing - Span-Based Neural Constituency Parsing - Evaluating Parsers - Partial Parsing - CCG Parsing; **Dependency Parsing:** Transition-Based Dependency Parsing - Graph-Based Dependency Parsing – Evaluation; **Logical Representations of Sentence Meaning:** Computational Desiderata for Representations - Model-Theoretic Semantics - First-Order Logic - Event and State Representations - Description Logics; **Word Senses and WordNet:** Word Senses - Relations Between Senses – WordNet, A Database of Lexical Relations - Word Sense Disambiguation. Case studies: Factoid Question Answering, Chatbots, Dialogue systems

| <b>Course Outcomes</b>                                                                                | <b>Cognitive Level</b> |
|-------------------------------------------------------------------------------------------------------|------------------------|
| At the end of this course, students will be able to:                                                  |                        |
| CO1.Implement language models using suitable programming language                                     | Apply                  |
| CO2.Analyze the performance of parsers and taggers with appropriate evaluation metrics                | Analyze                |
| CO3.Identify the appropriate sequence of NLP techniques required for solving a given research problem | Apply                  |
| CO4.Create real time applications using NLP functionalities                                           | Create                 |

#### **Text Book:**

T1.Daniel Jurafsky and James H Martin, “Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition”, 3<sup>rd</sup> Edition, Prentice Hall, 2020.

#### **Reference Books:**

- R1.U. S. Tiwary and Tanveer Siddiqui, “Natural Language Processing and Information Retrieval”, Oxford University Press, 2008.  
R2.Richard M Reese, “Natural Language Processing with Java”, Packt Publishing, 2015.

#### **Web References:**

1. <https://nptel.ac.in/courses/106101007/>
2. <https://nlp.stanford.edu/software/>

|                                               |                  |                                            |                       |
|-----------------------------------------------|------------------|--------------------------------------------|-----------------------|
| <b>Course Code: 24CPE010</b>                  |                  | <b>Course Title: Information Retrieval</b> |                       |
| <b>Course Category: Professional Elective</b> |                  | <b>Course Level: Mastery</b>               |                       |
| <b>L:T:P (Hours/Week)</b><br><b>3 0 0</b>     | <b>Credits:3</b> | <b>Total Contact Hours: 45</b>             | <b>Max Marks: 100</b> |

### **Course Objective:**

The course is intended to impart knowledge on evaluating IR models, applying text processing and web search operations.

### **Module I Information Retrieval Process**

**22 Hours**

Basic Concepts – Retrieval Process – Modeling – Classic Information Retrieval – Set Theoretic, Algebraic and Probabilistic Models – Structured Text Retrieval Models – Retrieval Evaluation- Languages – Key word based Querying – Pattern Matching – Structural Queries – Query Operations – User Relevance Feedback – Local and Global Analysis – Text and Multimedia languages- Data Models – Query Languages

### **Module II Text Operations and Web Searching**

**23 Hours**

Document Preprocessing – Clustering – Text Compression - Indexing and Searching – Inverted files – Boolean Queries – Sequential searching –User relevance Judgment - Spatial Access Methods – Generic Approach – One Dimensional Time Series – Two Dimensional Color Images – Feature Extraction. Searching the Web – Characterizing the Web – Search Engines – Parallel Information Retrieval – Distributed Information Retrieval.

| <b>Course Outcomes</b>                                                                                                                                                                                           | <b>Cognitive Level</b> |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|
| At the end of this course, students will be able to:                                                                                                                                                             |                        |
| CO1:Implement various information retrieval models including set theoretic, algebraic, and probabilistic models to efficiently retrieve relevant information from complex data collections.                      | Apply                  |
| CO2:Analyze the strengths and weaknesses of different data models using query languages and relevance feedback mechanisms for real time applications                                                             | Analyze                |
| CO3:Conduct a comparative analysis of document preprocessing pipelines, examining the effectiveness of tokenization, stemming, and document vectorization techniques in optimizing information retrieval systems | Evaluate               |
| CO4:Design a comprehensive multimedia retrieval system, outlining the architecture, data flow, and components required for efficient searching and retrieval of multimedia data                                  | Create                 |

#### **Text Book:**

T1. Ricardo Baeza-Yates, Berthier Ribeiro-Neto, "Modern Information Retrieval", 2<sup>nd</sup> Edition, ACM Press Books, 2011

#### **Reference Books:**

R1. Christopher D. Manning, Prabhakar Raghavan, Hinrich Schutze, "Introduction to Information Retrieval", Cambridge University Press, 2012

R2. Stefan Buttcher, Charles L. A. Clarke, Gordon V. Cormack, "Information Retrieval Implementing and Evaluating Search Engines", MIT Press, 2010

#### **Web References:**

1. <http://cse.iitkgp.ac.in/~pawang/courses/IR18.html>
2. <http://web.stanford.edu/class/cs276/>

|                                               |                  |                                            |                       |
|-----------------------------------------------|------------------|--------------------------------------------|-----------------------|
| <b>Course Code: 24CPE011</b>                  |                  | <b>Course Title: Social Network Mining</b> |                       |
| <b>Course Category: Professional Elective</b> |                  | <b>Course Level: Mastery</b>               |                       |
| <b>L:T:P (Hours/Week)</b><br>3 : 0 : 0        | <b>Credits:3</b> | <b>Total Contact Hours: 45</b>             | <b>Max Marks: 100</b> |

### **Course Objective:**

The course is intended to impart knowledge on relationships in social networks and analyze dynamic changes within social networks.

### **Module I                      Graph Theory and Social Networks                      22 Hours**

Aspects of networks - Graph - Paths and Connectivity – Distance and Breadth First Search - Network Datasets - Triadic Closure - Strength of Weak Ties - Network Structure –Social Media - Passive Engagement - Closure - Structural Holes - Social Capital - Betweenness Measures - Graph Partitioning. Homophily - Selection and Social Influence - Affiliation - Spatial Model of Segregation - Positive and Negative Relationships - Structure of the web - Link Analysis using Hubs and Authorities - PageRank - Applying Link Analysis in Web Search .

### **Module II                      Social Network Dynamics                      23 Hours**

Information Cascades - Power Laws - Rich-Get-Richer Phenomena and Unpredictability - Effect of Search Tools and Recommendation Systems-Cascading Behavior in Networks - Small-World Phenomenon - Six Degrees of Separation Epidemics - Structure and Randomness- Decentralized Search - Modeling the Process of Decentralized Search - Empirical Analysis and Generalized Models- Branching Processes –SIR Epidemic Model – SIS Epidemic Model- Synchronization- Transient Contacts and Dangers of Concurrency.

| <b>Course Outcomes</b>                                                                                                                                                                               | <b>Cognitive Level</b> |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|
| At the end of this course, students will be able to:                                                                                                                                                 |                        |
| CO1.Develop social network analysis model using graph theory to identify influential nodes, communities, patterns of homophily, social influence, and affiliation within real-world social networks. | Apply                  |
| CO2.Demonstrate web-based social network analysis in real-time scenarios, applying techniques such as link analysis and PageRank.                                                                    | Apply                  |
| CO3:Analyze the effects of network dynamics such as information cascades, power laws, and cascading behavior on real-world networks                                                                  | Analyze                |
| CO4:Create real time predictive models for epidemic spread within networks.                                                                                                                          | Create                 |

### **Text Book:**

T1.David Easley and Jon Kleinberg , “Networks, Crowds, and Markets: Reasoning About a Highly Connected World”, Cambridge University Press, 2010.

### **Reference Books:**

R1.Przemyslaw Kazienko, Nitesh Chawla, “Applications of Social Media and Social Network Analysis”, Springer,2015

R2.Guandong Xu ,Yanchun Zhang and Lin Li, “Web Mining and Social Networking – Techniques and Applications”, Springer, 2012

R3.Charu.C.Aggarwal, “Social Network Data Analytics”, Springer, 2011

### **Web References:**

1. <https://nptel.ac.in/courses/106106169/>

2. <https://archive.nptel.ac.in/courses/106/106/106106239/>

|                                               |                  |                                 |                       |
|-----------------------------------------------|------------------|---------------------------------|-----------------------|
| <b>Course Code: 24CPE012</b>                  |                  | <b>Course Title: Blockchain</b> |                       |
| <b>Course Category: Professional Elective</b> |                  | <b>Course Level: Mastery</b>    |                       |
| <b>L:T:P (Hours/Week)</b><br><b>3:0:0</b>     | <b>Credits:3</b> | <b>Total Contact Hours: 45</b>  | <b>Max Marks: 100</b> |

**Course Objective:**

The course is intended to impart knowledge on blockchain technologies for various security applications.

**Module I Blockchain and Bitcoin**

**23 Hours**

**Blockchain basics:** History – Types – Consensus - CAP Theorem

**Decentralization:** Methods – Routes - Full eco system - Organizations – platform.

**Cryptographic primitives:** Symmetric ciphers, DES, AES.

**Bitcoin basics:** Digital keys and addresses - transaction: life cycle, data structure, Types, mining – bitcoin networks: wallets, payments, innovation - Alt coins: Lite coin. Prime coin.

**Module II Ethereum and Smart contract**

**22 Hours**

**Ethereum:** Stages of Development – Components- MetaMask - EOAs and contracts - Test Ether faucet, Creating contract - interacting with contract - Ethereum Virtual Machine.

**Smart Contracts and Solidity:** Life cycle - Ethereum high level language - Building a Smart Contract with Solidity - Programming with solidity.

**Hyperledger:** Projects under Hyperledger - Hyperledger as a Protocol - Distributed Ledger - Fabric - Sawtooth Lake - Corda.

**Blockchain applications:** KYC using blockchain in industry 4.0 - Blockchain for securing HER - Blockchain based Food supply chain management.

| Course Outcomes                                                                                               | Cognitive Level |
|---------------------------------------------------------------------------------------------------------------|-----------------|
| At the end of this course, students will be able to:                                                          |                 |
| CO1:Demonstrate proficiency in selecting appropriate blockchain types for specific use cases and requirements | Apply           |
| CO2:Develop bitcoin payment module integrating with wallet for real time e-commerce applications              | Apply           |
| CO3:Examine the implications of deploying contracts and interacting with them in real-world scenarios,        | Analyze         |
| CO4:Evaluate the practical applications of blockchain technology across different industries.                 | Evaluate        |

### Text Books:

- T1. Imran Bashir, "Mastering Blockchain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained", 2nd Edition, Packt Publishing, 2018.
- T2. Antonopoulos and G. Wood, "Mastering Ethereum: Building Smart Contracts and Dapps", O'Reilly Publishing, 2018.
- T3. E. Golden Julie, J. Jesu Vedha Nayahi, and Noor Zaman Jhanjhi , "Blockchain Technology : Fundamentals, Applications, and Case Studies", CRC Press, 2021.

### Reference Books:

- R1. D. Drescher, "Blockchain Basics", Apress, 2017.
- R2. Antonopoulos, "Mastering Bitcoin", O'Reilly Publishing, 2015.
- R3. Narayanan, J. Bonneau, E. Felten, A. Miller, S. Goldfeder, "Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction", Princeton University Press, 2016.

### Web References:

1. <https://archive.nptel.ac.in/courses/106/104/106104220/>
2. <https://www.udemy.com/course/build-your-blockchain-az/>
3. <https://www.ibm.com/topics/blockchain>

|                                               |                  |                                             |                       |
|-----------------------------------------------|------------------|---------------------------------------------|-----------------------|
| <b>Course Code: 24CPE013</b>                  |                  | <b>Course Title: Embedded System Design</b> |                       |
| <b>Course Category: Professional Elective</b> |                  | <b>Course Level: Mastery</b>                |                       |
| <b>L:T:P (Hours/Week)</b><br><b>3:0:0</b>     | <b>Credits:3</b> | <b>Total Contact Hours: 45</b>              | <b>Max Marks: 100</b> |

### Course Objective

The course is intended to impart knowledge on embedded system architecture and designs for diverse socio-economic applications.

### Module I

**23 Hours**

**Embedded Computing:** Embedded Computers - Characteristics of Embedded Computing Applications - Challenges and performance in system design - Design Process: Requirements, Specification, Architectural Design, Designing hardware and software components, System Integration, Formalism for System Design, Structural and Behavioral Description - Design Example: Model Train Controller. **ARM processor:** Memory organization - Data operations – Features - Flow of Control. **TI C55x DSP:** Memory organization - Addressing modes - Data operations - Flow of Control - CPU Bus - Memory devices and systems. Designing with computing platforms - Design Examples: Alarm Clock, Audio player.

### Module II

**22 Hours**

**System Design Techniques:** Design Methodologies - Requirement Analysis, Specification - System Analysis and Architecture Design - Quality Assurance. **Automotive and Aerospace Systems:** Networked control systems in cars and airplanes - Vehicular networks - Safety and security - Design example: video accelerator - Application example: optical disk. **Multicore Embedded Wireless Sensor Network:** Architectures, Compute-Intensive Tasks, Application Domains, sensor nodes, Research challenges.

| <b>Course Outcomes</b>                                                                                                   | <b>Cognitive Level</b> |
|--------------------------------------------------------------------------------------------------------------------------|------------------------|
| At the end of this course, students will be able to:                                                                     |                        |
| CO1:Demonstrate the process of designing embedded systems to fulfill the requirements of industrial safety applications. | Apply                  |
| CO2:Analyze factors, including societal impacts, to decide on the best computing platforms for real-world applications.  | Analyze                |
| CO3:Analyze networked control system models for engineering applications employing diverse tools.                        | Evaluate               |
| CO4:Analyze multicore wireless sensor networks for compute-intensive tasks and research challenges.                      | Evaluate               |

### **Text Books:**

- T1. Wayne Wolf, "Computers as Components: Principles of Embedded Computing System Design", Morgan Kaufman Publishers, 4<sup>th</sup> Edition 2017.
- T2. Arslan Munir, Ann Gordon-Ross, Sanjay Ranka, "Modeling and optimization of parallel and distributed embedded systems", John Wiley & Sons Inc, 2016.

### **Reference Books:**

- R1. Rajkamal "Embedded Systems: Architecture, Programming and Design", Tata McGraw-Hill, 3<sup>rd</sup> Edition 2014.
- R2. Jane.W.S. Liu, "Real-Time systems", Pearson Education, LPE,2018.
- R3. Derek Molloy, "Exploring BeagleBone: Tools and Techniques for Building with Embedded Linux", Wiley, 2019.

### **Web References:**

- 1. <https://developer.arm.com/ip-products/processors/classic-processors>
- 2. <https://www.analog.com/en/products/processors-dsp/dsp/sharc.html>
- 3. <https://microcontrollerslab.com/embedded-systems-basics/>
- 4. <https://archive.nptel.ac.in/courses/108/102/108102169/>

|                                               |                  |                                       |                       |
|-----------------------------------------------|------------------|---------------------------------------|-----------------------|
| <b>Course Code: 24CPE014</b>                  |                  | <b>Course Title: Extended Reality</b> |                       |
| <b>Course Category: Professional Elective</b> |                  | <b>Course Level: Mastery</b>          |                       |
| <b>L:T:P (Hours/Week)</b><br><b>3:0:0</b>     | <b>Credits:3</b> | <b>Total Contact Hours: 45</b>        | <b>Max Marks: 100</b> |

### Course Objective

The course is intended to impart knowledge on creating 3D objects & AR assets using AR tools. The course aims to enable the learners to develop simple AR applications considering the human and legal factors.

### Module I

**23 Hours**

**Introduction:** Fundamentals of AR, VR and MR - XR system - Immersion in XR- MR Devices. **Foundation:** Session Management – 3D Objects – Textures – Surfaces – Adding Physics – Portal – Adding Objects. **AR tools:** Geometry – Textures – Lighting – Place Holders – User Interactions - Location Tracking & Beacons. **AR assets:** Face Tracking Sessions – Face Geometry – Creating Assets – Blend Shapes – Enhancing UX – Vehicle Physics.

### Module II

**22 Hours**

**XR Hardware and Software:** Hardware XR systems - VR Headsets - AR display devices, glasses - MR Devices - Software and Development Tools - Unity Game Engine. **Applications:** Gaming and Entertainment – Architecture and Construction – Science and Engineering – Health and Medicine – Education – Information Control and Big Data Visualization – Telerobotics and Telepresence. **Human Factors Considerations:** Physical Side Effects, Visual Side Effects – Legal Considerations – Moral and Ethical Considerations.

| <b>Course Outcomes</b>                                                                        | <b>Cognitive Level</b> |
|-----------------------------------------------------------------------------------------------|------------------------|
| At the end of this course, students will be able to:                                          |                        |
| CO1:Create a 3D object and apply different textures using Unity framework.                    | Apply                  |
| CO2:Create assets using AR tools for face tracking application                                | Apply                  |
| CO3:Develop a Simple XR application under entertainment domain.                               | Create                 |
| CO4:Analyze research directions of Augmented Reality considering the human and legal factors. | Analyze                |

### **Text Books:**

- T1. Steve Aukstakalnis, "Practical Augmented Reality A Guide to the Technologies, Applications and Human Factors for AR and VR", Pearson Education, Inc., 2017.
- T2. Ralf Doerner et al., "Virtual and Augmented Reality (VR/AR): Foundations and Methods of Extended Realities (XR)", Springer, 2022.

### **Reference Book:**

- R1.Julie A.Jacko, "The Human Computer Interaction Handbook: Fundamentals, Evolving Technologies and Emerging Applications", 3<sup>rd</sup> Edition, CRC Press, 2012.

### **Web References:**

- 1.[https://onlinecourses.swayam2.ac.in/ntr24\\_ed76/preview](https://onlinecourses.swayam2.ac.in/ntr24_ed76/preview)
- 2.<https://developers.google.com/ar/develop/java/quickstart>
- 3.<https://learn.unity.com/learn/pathway/mobile-ar-development>

|                                               |                   |                                                    |                       |
|-----------------------------------------------|-------------------|----------------------------------------------------|-----------------------|
| <b>Course Code: 24CPE015</b>                  |                   | <b>Course Title: Advanced Software Engineering</b> |                       |
| <b>Course Category: Professional Elective</b> |                   | <b>Course Level: Mastery</b>                       |                       |
| <b>L:T:P (Hours/Week)</b><br><b>3:0:0</b>     | <b>Credits: 3</b> | <b>Total Contact Hours: 45</b>                     | <b>Max Marks: 100</b> |

### **Course Objectives:**

The course is intended to impart knowledge on object-oriented software development process and quality measurement. The course also intends to provide exposure on the various stages of software development such as Requirement analysis, design, implementation, testing and management.

### **Module I**

**23 Hours**

**Requirement Elicitation:** Software Development Life cycle models – Requirement Elicitation Techniques – Use case Approach – SRS Document – Requirements Change Management. **Software Estimation:** Lorenz and Kidd Estimation Method – Use Case points Method – Class Point method – Object Oriented Function Point – Risk Management. **Software Development:** Object Oriented Analysis – Class diagrams – Object Oriented Design – Interaction and sequence diagrams – Generating test cases – Implementation – Activity and State chart diagrams – Database access – Coding standards – Refactoring and Reusability. **Case Studies:** Learner Management System – ATM System – Home Automation System.

### **Module II**

**22 Hours**

**Software Quality and Metrics:** Quality Models – Measurement Basics – Analyzing the metric data – Measuring size and Structure – Measuring Quality – Object Oriented Metrics. **Software Testing:** Testing and Verification Techniques – Checklist – Functional, Structural, Class, State-based, Mutation testing – Levels of testing – Testing tools. **Software Maintenance:** Categories of Software Maintenance – Challenges – Software Rejuvenation – Estimation of Maintenance effort – Configuration Management – Regression Testing.

| <b>Course Outcomes</b>                                                                                    | <b>Cognitive Level</b> |
|-----------------------------------------------------------------------------------------------------------|------------------------|
| At the end of this course, students will be able to:                                                      |                        |
| CO1.Compare the functionalities of traditional and object oriented Software Development Life cycle models | Apply                  |
| CO2.Apply Object Oriented analysis and design techniques to develop a software                            | Apply                  |
| CO3.Analyze the quality aspects of the software using various metrics and testing techniques              | Analyze                |
| CO4.Formulate appropriate procedure for software maintenance and configuration management.                | Create                 |

### **Text Book:**

T1. Yogesh Singh, Ruchika Malhotra, “Object-Oriented Software Engineering”, PHI Learning, 2012.

### **Reference Books:**

- R1. Bernd Bruegge and Allen H. Dutoit, “Object-Oriented Software Engineering: Using UML, Patterns and Java”, 4<sup>th</sup> Edition, Pearson Education Asia, 2013.
- R2. Deven N. Shah, G.P. Bherde, “Object Oriented Software Engineering”, Dreamtech Press, 2010.
- R3. Ian Holmes, Benjamin Curtis, Kenneth Gu, “Object Oriented Software Engineering”, Kruger Brentt Publishers, 2024.

### **Web References:**

- 1. <https://online.stanford.edu/courses/cs108-object-oriented-systems-design>
- 2. [https://onlinecourses.nptel.ac.in/noc22\\_cs61/preview](https://onlinecourses.nptel.ac.in/noc22_cs61/preview)

|                                               |                   |                                                |                       |
|-----------------------------------------------|-------------------|------------------------------------------------|-----------------------|
| <b>Course Code: 24CPE016</b>                  |                   | <b>Course Title: Nature Inspired Computing</b> |                       |
| <b>Course Category: Professional Elective</b> |                   | <b>Course Level: Mastery</b>                   |                       |
| <b>L:T:P (Hours/Week)</b><br><b>3:0:0</b>     | <b>Credits: 3</b> | <b>Total Contact Hours: 45</b>                 | <b>Max Marks: 100</b> |

### Course Objectives

The course is intended to impart knowledge on various Evolutionary and Swarm Intelligence based optimization techniques to solve computational problems. The course intends to provide exposure on the working principle and applications of nature inspired algorithms in real world scenarios.

### Module I

**23 Hours**

**Introduction:** Optimization Techniques – Multi-objective Optimization – Optimization Functions. **Classic Evolutionary Algorithms:** Genetic Algorithms – Genetic Programming – Evolutionary Programming – Evolutionary Algorithm Variations – Direct Search Algorithms – Simulated Annealing. **Recent Evolutionary Algorithms:** Differential Evolution – Biogeography-Based Optimization – Cultural Algorithms – Opposition-Based Learning. **Case Studies:** Traveling Salesman Problem – Music Generation.

### Module II

**22 Hours**

**Introduction:** Biological Foundations of Swarm Intelligence – Role of Swarm Intelligence in Optimization. **Classic SI Algorithms:** Ant Colony Optimization – Artificial Bee Colony Optimization – Bat Algorithm – Particle Swarm Optimization – Grey Wolf Optimization. **Recent SI Algorithms:** Bacteria Foraging Algorithm – Firefly based Optimization – Gravitational Search Algorithm – Cuckoo Search Optimization – Elephant Herding Optimization. **Case Studies:** White Blood Cell Classification – Swarm Robotics.

| <b>Course Outcomes</b>                                                                                       | <b>Cognitive Level</b> |
|--------------------------------------------------------------------------------------------------------------|------------------------|
| At the end of this course, students will be able to:                                                         |                        |
| CO1. Identify appropriate optimization technique for the given research problem.                             | Apply                  |
| CO2. Apply Evolutionary and Swarm Intelligence based optimization techniques to solve computational problems | Apply                  |
| CO3. Analyze the performance of nature-inspired algorithms in real world applications                        | Analyze                |
| CO4. Formulate solutions for Metaheuristic problems using nature inspired algorithms                         | Create                 |

### **Text Books:**

- T1. Dan Simon, "Evolutionary Optimization Algorithms", Wiley & Sons, 2013.  
T2. Adam Slowik, "Swarm Intelligence Algorithms – A Tutorial", CRC Press, 2<sup>nd</sup> Edition, 2021.

### **Reference Books:**

- R1. Altaf Q. H Badar, "Evolutionary Optimization Algorithms", CRC Press, 2022.  
R2. George Lindfield and John Penny, "Introduction to Nature Inspired Optimization", Academic Press, 2017.  
R3. Xin-She yang, "Nature-Inspired Computation and Swarm Intelligence: Algorithms, Theory and Applications", Academic Press, Elsevier, 2020. (Case Studies)

### **Web References:**

1. <https://web.itu.edu.tr/~etaner/courses/NIC/>  
2. <https://archive.nptel.ac.in/courses/112/103/112103301/>

|                                               |                   |                                        |                       |
|-----------------------------------------------|-------------------|----------------------------------------|-----------------------|
| <b>Course Code: 24CPE017</b>                  |                   | <b>Course Title: Wireless Security</b> |                       |
| <b>Course Category: Professional Elective</b> |                   | <b>Course Level: Mastery</b>           |                       |
| <b>L:T:P (Hours/Week)</b><br><b>3:0:0</b>     | <b>Credits: 3</b> | <b>Total Contact Hours: 45</b>         | <b>Max Marks: 100</b> |

### **Course Objectives:**

The course is intended to equip students with the knowledge and skills to identify security vulnerabilities in wireless and mobile communication systems.

### **Module I**

**23 Hours**

Wireless network - Wireless Threat - wireless security protocols and cryptography - security consideration for wireless network - wireless standards and technologies. Implementing wireless LANs: Security consideration - Enabling secure wireless access to data - Real world Example.

### **Module II**

**22 Hours**

Threats, hacking and virus in Mobile communication - Wireless system security – cryptography – cryptosystem - Digital Signature - Authentication-key distribution and management - Security of GSM - GSM Infrastructure - Attacks on GSM - Encryption Algorithm - Security of multimedia system - Security of Adhoc network - Routing protocols - Attacks – Authentication - Key Management.

| <b>Course Outcomes</b>                                                                                                                                      | <b>Cognitive Level</b> |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|
| At the end of this course, students will be able to:                                                                                                        |                        |
| CO1.Analyze the security considerations and vulnerabilities in different wireless network technologies and standards through real-world case studies        | Analyze                |
| CO2.Develop a secure wireless LAN system by integrating appropriate wireless security protocols and cryptographic techniques.                               | Apply                  |
| CO3.Apply cryptographic methods and authentication techniques to secure GSM and multimedia systems against common threats.                                  | Apply                  |
| CO4.Develop a comprehensive security framework for mobile communication systems, addressing threats, attacks, and key management in GSM and Adhoc networks. | Create                 |

### **Text Books:**

- T1.Merritt Maxim David Pollino," Wireless Security", McGraw-Hill, 2002.  
T2.Noureddine Boudriga, "Security of Mobile Communications", CRC Press 2010.

### **Reference Books:**

- R1. J Minella "Wireless Security Architecture: Designing and Maintaining Secure Wireless " , John Wiley & Sons Inc 2022.  
R2. Jim Doherty , "Wireless and Mobile Device Security" Jones and Bartlett Publishers, Inc, 2021.

### **Web References:**

- 1.<https://nptel.ac.in/courses/106/105/106105160/>  
2.[https://www.tutorialspoint.com/wireless\\_security/index.htm](https://www.tutorialspoint.com/wireless_security/index.htm)

|                                               |                   |                                     |                       |
|-----------------------------------------------|-------------------|-------------------------------------|-----------------------|
| <b>Course Code: 24CPE018</b>                  |                   | <b>Course Title: Industrial IOT</b> |                       |
| <b>Course Category: Professional Elective</b> |                   | <b>Course Level: Mastery</b>        |                       |
| <b>L:T:P (Hours/Week)</b><br><b>3:0:0</b>     | <b>Credits: 3</b> | <b>Total Contact Hours: 45</b>      | <b>Max Marks: 100</b> |

### **Course Objectives:**

The course is intended to impart knowledge on basic concepts of Industrial Internet of Things.

### **Module I**

**23 Hours**

**Introduction and Architecture of IoT:** Introduction – Definition and characteristics of IoT – Physical and Logical Design of IoT - Communication models and APIs – Challenges in IoT - Evolution of IoT- Components of IoT - A Simplified IoT Architecture – Core IoT Functional Stack. **Industrial IoT:** IIoT-Introduction, Industrial IoT: Business Model and Reference Architecture: IIoT-Business Models, Industrial IoT- Layers: IIoT Sensing, IIoT Processing, IIoT Communication, IIoT Networking. **IIOT Analytics:** Big Data Analytics and Software Defined Networks, Machine Learning and Data Science, Julia Programming, Data Management with Hadoop.

### **Module II**

**22 Hours**

**IoT Security:** Industrial IoT: Security and Fog Computing - Cloud Computing in IIoT, Fog Computing in IIoT, Security in IIoT. **Case Study:** Industrial IOT- Application Domains: Oil, chemical and pharmaceutical industry, Applications of UAVs in Industries, Real case studies: Milk Processing and Packaging Industries, Manufacturing Industries.

| <b>Course Outcomes</b>                                                                              | <b>Cognitive Level</b> |
|-----------------------------------------------------------------------------------------------------|------------------------|
| At the end of this course, students will be able to:                                                |                        |
| CO1:Analyze the basic concepts, architecture, and communication models of IoT, including challenges | Analyze                |
| CO2:Apply Industrial IoT business models and analytics techniques to solve real-world problems.     | Apply                  |
| CO3:Construct secure solutions for Industrial IoT using cloud and fog computing technique           | Apply                  |
| CO4:Analyze case studies of Industrial IoT applications across various industries and UAVs          | Analyze                |

### **Text Books:**

- T1.David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry," IoT Fundamentals: Networking Technologies, Protocols, and Use cases for the Internet of Things", Pearson Education, 2017.
- T2. Olivier Hersent, David Boswarthick and Omar Elloumi, "The Internet of Things-Key Applications and Protocols", Wiley, 2021.

### **Reference Books:**

- R1. Giacomo Veneri, Antonio Capasso, "Hands-On Industrial Internet of Things: Create a powerful Industrial IoT", Packt, 2018.
- R2. Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things", Apress, 2017.

### **Web References:**

1. <https://nptel.ac.in/courses/106105166>
2. [https://www.cse.wustl.edu/~jain/cse570-15/ftp/iot\\_prot/index.html](https://www.cse.wustl.edu/~jain/cse570-15/ftp/iot_prot/index.html)

|                                               |                   |                                               |                       |
|-----------------------------------------------|-------------------|-----------------------------------------------|-----------------------|
| <b>Course Code: 24CPE019</b>                  |                   | <b>Course Title: Deep Learning Techniques</b> |                       |
| <b>Course Category: Professional Elective</b> |                   | <b>Course Level: Mastery</b>                  |                       |
| <b>L:T:P (Hours/Week)</b><br><b>3:0:0</b>     | <b>Credits: 3</b> | <b>Total Contact Hours: 45</b>                | <b>Max Marks: 100</b> |

### Course Objectives:

This course aims to provide a comprehensive foundation in deep learning, covering essential concepts and techniques. By the end of the course, students will develop practical skills in designing, training, and applying these models to real-world data and problems.

### Module I

**23 Hours**

**Introduction to Deep Learning:** Basic concept of Neurons – Linear Perceptrons as Neurons – Feed-Forward Neural Networks – Linear Neurons and their Limitations – Multilayer Perceptrons - Forward Propagation, Backward Propagation, and Computational Graphs-Generalization in Deep Learning-Dropout. **Convolution Neural Networks:** Convolutions, Padding and Stride, Multiple Input and Multiple Output Channels, Pooling, LeNet. **Pre-Trained CNN Models:** Self-Supervised Pretraining, AlexNet, VGG, NiN, GoogleNet, ResNet, DenseNet, Transfer Learning. **Region-Based CNNs:** R-CNN, Fast R-CNN, Faster R-CNN, Mask RCNN, Sequence modeling using recurrent nets, Deep Generative Models. **Case Study:** Image segmentation using CNNs.

### Module II

**22 Hours**

**Recurrent Neural Networks:** Long Short-Term Memory (LSTM)- Gated Recurrent Units (GRU)- Deep Recurrent Neural Networks-Bidirectional Recurrent Neural Networks-Machine Translation and the Dataset-The Encoder-Decoder Architecture-Sequence-to-Sequence Learning for Machine Translation. **Generative Adversarial Networks:** Generator, Discriminator, Training, GAN variants. **Optimization Algorithms:** Optimization and Deep Learning, Convexity, Gradient Descent, Stochastic Gradient Descent, RMSProp, Adadelta, Adam, Common Image Augmentation Methods. **Case Study:** Text generation with LSTM , Speech Processing and Image Captioning using RNNs- Image generation with Generative Adversarial Networks.

| <b>Course Outcomes</b>                                                                                                                                            | <b>Cognitive Level</b> |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|
| At the end of this course, students will be able to:                                                                                                              |                        |
| CO1:Apply the principles of neurons, perceptron, and neural networks, to design and train multilayer models for solving real-world deep learning problems.        | Apply                  |
| CO2:Apply CNN architectures and techniques to design and optimize convolutional networks for addressing complex practical challenges across various domains       | Apply                  |
| CO3:Analyze the performance of different Recurrent Neural Network (RNN) by comparing their effectiveness in solving sequential data tasks across various domains. | Analyze                |
| CO4:Develop deep generative models for real-world applications.                                                                                                   | Create                 |

### **Text Book:**

- T1. Aston Zhang, Zachary C. Lipton, Mu Li and Alexander J. Smola, "Dive into Deep Learning", Cambridge University Press, 2023.
- T2. Francois Chollet, "Deep Learning with Python", Manning Publications, 2021.

### **Reference Books:**

- R1. Ian Good Fellow, Yoshua Bengio, Aaron Courville, "Deep Learning", MIT Press, 2017.
- R2. Nikhil Buduma, Nicholas Locascio, "Fundamentals of Deep Learning: Designing Next- Generation Machine Intelligence Algorithms", O'Reilly Media, 2017.
- R3. Josh Patterson, Adam Gibson, "Deep Learning: A Practitioner's Approach", O'Reilly Media, 2017

### **Web References:**

1. <https://nptel.ac.in/courses/106106184>

|                                               |                   |                                             |                       |
|-----------------------------------------------|-------------------|---------------------------------------------|-----------------------|
| <b>Course Code: 24CPE020</b>                  |                   | <b>Course Title: Reinforcement Learning</b> |                       |
| <b>Course Category: Professional Elective</b> |                   | <b>Course Level: Mastery</b>                |                       |
| <b>L:T:P (Hours/Week)</b><br><b>3:0:0</b>     | <b>Credits: 3</b> | <b>Total Contact Hours: 45</b>              | <b>Max Marks: 100</b> |

### Course Objectives

The course is intended to impart knowledge on a type of machine learning where agents learn to make decisions by interacting with an environment. The course intends to provide exposure reinforcement learning techniques to real-world problems such as game AI, robotics, and autonomous decision-making systems.

### Module I

**23 Hours**

**Introduction:** Introduction to Reinforcement Learning–Elements of Reinforcement Learning–Limitations and Scope – History of Reinforcement Learning– The Agent-Environment Interface - An-Armed Bandit Problem. **Markov Decision Process and Dynamic Programming:** Markov Decision Process – Action Space – Policy – Episode – Return and Discount Factor - The Markov Property – Markov Decision Processes – Bellman Equation – Dynamic Programming – Value Iteration and Policy Iteration. **Monte Carlo Methods and Temporal Methods:** Understanding Monte Carlo Method – Prediction and Control Tasks – Monte Carlo Prediction – First and Every Visit – Monte Carlo Control – Understanding Temporal Difference Learning – TD Prediction – On-Policy TD Control – SARSA – Off-Policy TD Control – Q-Learning.

### Module II

**22 Hours**

**Deep Q Networks and its Variants:** DQN – replay Buffer – Loss functions – Target Function – Architecture of DQN – Double DQN - DQN with prioritized Experience replay – Dueling DQN – Deep Recurrent Method.**Function Approximation:** Getting Started with Policy Gradient Methods – Policy Gradient Intuition – Variance Reduction Methods – Actor – Critic Methods – A2C , A3C , A3C – Deep Gradient Policy Gradient – Twin Delayed DDPG – Trust Region Policy Approximation – TRPO -Proximal Policy Optimization.

| <b>Course Outcomes</b>                                                      | <b>Cognitive Level</b> |
|-----------------------------------------------------------------------------|------------------------|
| At the end of this course, students will be able to:                        |                        |
| CO1.Illustrate Markov Decision Process and Bellman Equation for learning    | Apply                  |
| CO2.Apply to optimize and fine-tune RL agents in different environments.    | Apply                  |
| CO3.Implement and analyze Time difference learning for real world problems. | Analyze                |
| CO4.Develop Approximation methods of learning techniques.                   | Create                 |

### **Text Books:**

- T1.Richard S. Sutton and Andrew G. Barto, Introduction to Reinforcement Learning, 2<sup>nd</sup> Edition, MIT Press. 2018.
- T2.Sudharsan Ravichandiran, “Deep Reinforcement Learning with Python”, 2<sup>nd</sup> Edition, Packet Publishing, 2020.

### **Reference Books:**

- R1. Kevin P Murphy, “Machine Learning: A Probabilistic Perspective”, 2<sup>nd</sup> Edition, MIT Press, 2022.
- R2. Laura Graesser and Wah Loon Keng, “Foundations of Deep Reinforcement learning: theory and Practice in Python”, Pearson, 2022.
- R3. Csaba Szepesvari, “Algorithms for Reinforcement Learning (Synthesis Lectures on Artificial Intelligence & Machine Learning)”, Morgan & Claypool Publishers, 2010.

### **Web Reference:**

1. [http://cse.iitkgp.ac.in/~adas/courses/rl\\_aut2021/syllabus.html/](http://cse.iitkgp.ac.in/~adas/courses/rl_aut2021/syllabus.html/)

|                                           |                   |                                         |                       |
|-------------------------------------------|-------------------|-----------------------------------------|-----------------------|
| <b>Course Code: 24CPO301</b>              |                   | <b>Course Title: Business Analytics</b> |                       |
| <b>Course Category: Open Elective</b>     |                   | <b>Course Level: Practice</b>           |                       |
| <b>L:T:P (Hours/Week)</b><br><b>3:0:0</b> | <b>Credits: 3</b> | <b>Total Contact Hours: 45</b>          | <b>Max Marks: 100</b> |

### Course Objectives

The course is intended to impart knowledge on various data analysis techniques to solve business problems. The course intends to provide exposure to develop skills in data-driven decision-making.

### Module I

**23 Hours**

**Introduction:** Data-Analytic Thinking - Data Science, Engineering, and Data-Driven Decision Making - Business Problems and Data Science Solutions - Introduction to Predictive Modeling: From Correlation to Supervised Segmentation. **Prescriptive Analytics:** Testing retail analytics-Simulating the future pension analytics-: Optimizing complex decisions sales force analytics-Optimizing with multiple objectives portfolio analytics. **Data Analytics:** Visual representations of data in Excel- Define and calculate descriptive statistics-Create scatter plots and calculate the correlation coefficient- Deep Analytics and visualization.

### Module II

**22 Hours**

**Introduction:** Web Mining -AWS Elastic Map Reduce - AWS CLI -Sentiment analysis- Applications of web mining. **Operational Analytics:** Operational Analytics Vs Traditional Analytics-Challenges of Operational Analytics - Cloud ware house- Operational Analytics in Modern Data stack-Use cases- benefits.

| <b>Course Outcomes</b>                                                                 | <b>Cognitive Level</b> |
|----------------------------------------------------------------------------------------|------------------------|
| At the end of this course, students will be able to:                                   |                        |
| CO1.Apply the various optimizations for prescriptive analytics in different scenarios. | Apply                  |
| CO2.Design the data representations and calculate statistics, correlation coefficient. | Apply                  |
| CO3.Analyze the big data and web mining in various applications.                       | Analyze                |
| CO4.Investigate the Operational Analytics in modern data stack.                        | Evaluate               |

### **Text Books:**

- T1.Foster Provost, Tom Fawcett, “Data Science for Business”, O’Reilly 2013.  
T2.Peter C. Bruce Galit, Shmueli, Nitin R. Patel, “Data Mining for Business Intelligence, Concepts, Techniques and Applications”, Wiley India Pvt Ltd, 2008.

### **Reference Books:**

- R1. Stephen G. Powell, Kenneth R. Baker, “Management Science: The Art of Modeling with Spreadsheets”, 4th edition, John Wiley & Sons, 2013.  
R2. Rajkumar Buyya, S. Thamarai Selvi, "Big Data: Principles and Paradigms", Morgan Kaufmann Publishers In, 2016.

### **Web References:**

1. <https://web.stanford.edu/~hastie/ElemStatLearn/>
2. <https://hightouch.com/blog/what-is-operational-analytics>

|                                           |                   |                                                  |                       |
|-------------------------------------------|-------------------|--------------------------------------------------|-----------------------|
| <b>Course Code: 24CPO302</b>              |                   | <b>Course Title: Cybersecurity and Forensics</b> |                       |
| <b>Course Category: Open Elective</b>     |                   | <b>Course Level: Practice</b>                    |                       |
| <b>L:T:P (Hours/Week)</b><br><b>3:0:0</b> | <b>Credits: 3</b> | <b>Total Contact Hours: 45</b>                   | <b>Max Marks: 100</b> |

## Course Objectives

The course is intended to impart knowledge on cybersecurity and computer forensics through an in-depth study of security principles, forensic methodologies, and best practices for managing and analyzing cyber threats.

### Module I

**23 Hours**

**Introduction:** Basics of Cyber Security – Cyber Security policy – Domain of Cyber Security Policy: Laws and Regulations, Enterprise Policy, Technology Operations, Technology Configuration - Strategy Versus Policy – Cyber Security Evolution: Productivity, Internet, E-commerce, Counter Measures, Challenges. **Cybersecurity Objectives and Guidance:** Cyber Security Metrics – Security Management Goals – Counting Vulnerabilities – Security Frameworks: E-Commerce Systems, Industrial Control Systems, Personal Mobile Devices – Security Policy Objectives – Guidance for Decision Makers - Cyber Security Management – Catalog Approach. **Cyber Governance Issues:** Net Neutrality, Internet Names, and Numbers, Copyright and Trademarks, Email and Messaging. **Cyber User Issues:** Malvertising, Impersonation, Appropriate Use, Cyber Crime, Geolocation, Privacy

### Module II

**22 Hours**

**Cyber Conflict Issues:** Intellectual, property Theft, Cyber Espionage, Cyber Sabotage, Cyber Welfare. **Scope of computer forensics:** Introduction, Types of Evidence, Investigator skills, Importance, History of Computer Forensics, Law Enforcement Training-Computer Forensics Lab Requirements. **Network Forensics:** Tools, Networking Devices, Understanding the OSI Model, Advanced Persistent Threats, Investigating a Network Attack. **Mobile Forensics:** Cellular Network, Handset Specifications, Mobile Operating Systems, Standard Operating Procedures for Handling Handset Evidence, Handset Forensics.

| <b>Course Outcomes</b>                                                                               | <b>Cognitive Level</b> |
|------------------------------------------------------------------------------------------------------|------------------------|
| At the end of this course, students will be able to:                                                 |                        |
| CO1:Analyze the evolution of cybersecurity and its policies for engineering applications.            | Analyze                |
| CO2:Choose appropriate cybersecurity metrics and frameworks to enforce cybersecurity policies        | Analyze                |
| CO3:Analyze cybersecurity issues faced by decision makers to interpret the cybersecurity environment | Analyze                |
| CO4:Investigate the knowledge requirements for careers in forensics.                                 | Evaluate               |

### **Text Books:**

- T1. Jennifer L. Bayuk, J. Healey, P. Rohmeyer, Marcus Sachs , Jeffrey Schmidt, Joseph Weiss, "Cyber Security Policy Guidebook", John Wiley & Sons, 2017.
- T2. Darren R. Hayes, "A Practical Guide to Computer Forensics Investigations", 2<sup>nd</sup> Edition Pearson, 2020.

### **Reference Books:**

- R1. Bill Nelson, Amelia Phillips, Christopher Steuart, "Computer Forensics and Investigations", 3<sup>rd</sup> Edition, Cengage learning, 2020.
- R2. Eugene H. Spafford, Leigh Metcalf , Josiah Dykstra. "Cybersecurity Myths and Misconceptions", Pearson Education, 2024

### **Web References:**

1. <https://www.coursera.org/learn/introduction-to-cybersecurity-fundamentals>
2. <https://www.udemy.com/course/2021-beginners-guide-to-cyber-security>