PG-R26 Curriculum
with effective from 2026-27

# Computer Science and Engineering

Scheme of Instruction and Syllabi of

**M.Tech. I to IV Semester of**

Two Year Degree Course


**CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY**

(An Autonomous Institute | Affiliated to Osmania University)

Accreditated by NAAC (A++)

Kokapet Village, Gandipet Mandal, Hyderabad-500075, Telangana

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# CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A)
# M.TECH-COMPUTER SCIENCE AND ENGINEERING
**R26 Regulation with effect from A.Y. 2026-27**

## DEPARTMENT VISION & MISSION

**Department Vision**

To be in the frontiers of Computer Science and Engineering with academic excellence and Research.

**Department Mission**

The mission of the Computer Science and Engineering Department is to:

1. Educate students with the best practices of Computer Science by integrating the latest research into the curriculum
2. Develop professionals with sound knowledge in theory and practice of Computer Science and Engineering
3. Facilitate the development of academia-industry collaboration and societal outreach programs
4. Prepare students for full and ethical participation in a diverse society and encourage lifelong learning.

## PROGRAM EDUCATION OBJECTIVES (PEOs)

**PEO 1:** Will be able to practice their profession with confidence and global competitiveness by making intellectual contributions.

**PEO 2:** Will pursue a life-long career of personal and professional growth with superior work ethics and character.

**PEO 3:** Will be engaged in research leading to innovations/products or become a successful entrepreneur.

## PROGRAM OUTCOMES (POs)

**PO 1:** An ability to independently carry out research /investigation and development work to solve practical problems

**PO 2:** An ability to write and present a substantial technical report/document

**PO 3:** Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.

**PO 4:** An ability to pursue higher studies or provide solutions for complex real world problems.

**CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY**
**R26 (In line with AICTE Model Curriculum) with effect from AY 2026-27**

**M. Tech. (Computer Science and Engineering)**

**SEMESTER – I**

| S. No | Course Code | Title of the Course | Scheme of Instruction | | | Scheme of Examination | | | Credits |
|---|---|---|---|---|---|---|---|---|---|
| | | | Hours per Week | | | Duration of SEE in Hours | Maximum Marks | | |
| | | | L | T | P/D | | CIE | SEE | |
| **THEORY** | | | | | | | | | |
| 1. | 26CSC101 | Data Science and Big Data Analytics | 3 | - | - | 3 | 40 | 60 | 3 |
| 2. | 26CSC102 | Advanced Algorithms | 3 | - | - | 3 | 40 | 60 | 3 |
| 3. | 26CSExxx | Professional Elective-I | 3 | - | - | 3 | 40 | 60 | 3 |
| 4. | 26CSExxx | Professional Elective-II | 3 | - | - | 3 | 40 | 60 | 3 |
| 5. | 26xxxxxx | Audit Course-1 | 2 | - | - | 2 | - | 50 | Non Credit |
| **PRACTICAL** | | | | | | | | | |
| 6. | 26CSC103 | Advanced Algorithms Lab | - | - | 2 | - | 50 | - | 1 |
| 7. | 26CSExxx | Professional Elective-II Lab | - | - | 3 | - | 50 | - | 1.5 |
| 8. | 26CSC104 | Mini Project | - | - | 3 | - | 50 | - | 1.5 |
| **Total** | | | **14** | **-** | **8** | **-** | **310** | **290** | **16** |

**L: Lecture** **D: Drawing** **CIE: Continuous Internal Evaluation**
**T: Tutorial** **P: Practical/ Dissertation** **SEE-Semester End Examination**

| **Professional Elective-I** | |
|---|---|
| 26CSE101 | Soft Computing |
| 26CSE102 | Advanced Databases |
| 26CSE103 | Computer Vision and Image Processing |
| 26CSE104 | Software Project Management |
| 26CSE105 | Advanced Optimization Techniques |

| **Professional Elective-II** | |
|---|---|
| 26CSE106 | Deep Learning |
| 26CSE107 | Concurrent Programming |
| 26CSE108 | Data Visualization |
| 26CSE109 | Software Defined Networks |
| 26CSE110 | Network Security |

| **Professional Elective – II Lab** | |
|---|---|
| 26CSE111 | Deep Learning Lab |
| 26CSE112 | Concurrent Programming Lab |
| 26CSE113 | Data Visualization Lab |
| 26CSE114 | Software Defined Networks Lab |
| 26CSE115 | Network Security Lab |

**CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY**
**R26 (In line with AICTE Model Curriculum) with effect from AY 2026-27**

**M. Tech. (Computer Science and Engineering)**

**SEMESTER – II**

| S. No | Course Code | Title of the Course | Scheme of Instruction | | | Scheme of Examination | | | Credits |
|---|---|---|---|---|---|---|---|---|---|
| | | | Hours per Week | | | Duration of SEE in Hours | Maximum Marks | | |
| | | | L | T | P/D | | CIE | SEE | |
| **THEORY** | | | | | | | | | |
| 1. | 26CSC105 | Cyber Security | 3 | - | - | 3 | 40 | 60 | 3 |
| 2. | 26CSC106 | Distributed Cloud Computing | 3 | - | - | 3 | 40 | 60 | 3 |
| 3. | 26CSC107 | Natural Language Processing | 3 | - | - | 3 | 40 | 60 | 3 |
| 4. | 26CSC108 | Research Methodologies in Computer Science and IPR | 1 | - | - | 1 | 40 | 60 | 1 |
| 5. | 26CSExxx | Professional Elective-III | 3 | - | - | 3 | 40 | 60 | 3 |
| 6. | 26xxxxxx | Audit Course-2 | 2 | - | - | 2 | - | 50 | Non Credit |
| **PRACTICAL** | | | | | | | | | |
| 7. | 26CSC109 | Cyber Security Lab | - | - | 2 | - | 50 | - | 1 |
| 8. | 26CSC110 | Natural Language Processing Lab | - | - | 3 | - | 50 | - | 1.5 |
| 9. | 26CSExxx | Professional Elective-III Lab | - | - | 3 | - | 50 | - | 1.5 |
| **Total** | | | **15** | | **8** | **-** | **350** | **350** | **17** |

**L: Lecture** **D: Drawing** **CIE: Continuous Internal Evaluation**
**T: Tutorial** **P: Practical/Dissertation** **SEE-Semester End Examination**

| Professional Elective – III | |
|---|---|
| 26CSE116 | Generative AI |
| 26CSE117 | Internet of Things |
| 26CSE118 | Artificial Intelligence for Robotics |
| 26CSE119 | Devops Tools |
| 26CSE120 | Web Intelligence |

| Professional Elective – III Lab | |
|---|---|
| 26CSE121 | Generative AI Lab |
| 26CSE122 | Internet of Things Lab |
| 26CSE123 | Artificial Intelligence for Robotics Lab |
| 26CSE124 | Devops Tools Lab |
| 26CSE125 | Web Intelligence Lab |

**CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY**
**R26 (In line with AICTE Model Curriculum) with effect from AY 2026-27**

**M. Tech. (Computer Science and Engineering)**

**SEMESTER – III**

| S. No | Course Code | Title of the Course | Scheme of Instruction | | | Scheme of Examination | | | Credits |
|---|---|---|---|---|---|---|---|---|---|
| | | | Hours per Week | | | Duration of SEE in Hours | Maximum Marks | | |
| | | | L | T | P/D | | CIE | SEE | |
| **THEORY** | | | | | | | | | |
| 1. | 26CSExxx | Professional Elective – IV | 3 | - | - | 3 | 40 | 60 | 3 |
| 2. | 26CSExxx | Professional Elective – V | 3 | - | - | 3 | 40 | 60 | 3 |
| 3. | 26xxxxxx | Open Elective | 3 | - | - | 3 | 40 | 60 | 3 |
| **DISSERATATION** | | | | | | | | | |
| 4. | 26CSC111 | Dissertation Phase-I | - | - | 20 | - | 100 | - | 10 |
| **Total** | | | **9** | | **20** | **–** | **220** | **180** | **19** |

**L: Lecture** **D: Drawing** **CIE: Continuous Internal Evaluation**
**T: Tutorial** **P: Practical/Dissertation** **SEE-Semester End Examination**

| Professional Elective – IV | |
|---|---|
| 26CSE126 | Advanced Deep Learning |
| 26CSE127 | Parallel and High Performance Computing |
| 26CSE128 | Extended Reality |
| 26CSE129 | Software Quality and Testing |
| 26CSE130 | Blockchain Technology |

| Professional Elective-V | |
|---|---|
| 26CSE131 | Algorithmic Game Theory |
| 26CSE132 | Fog and Edge Computing |
| 26CSE133 | Quantum Computing |
| 26CSE134 | Social Network and Analytics |
| 26CSE135 | Digital Forensics |

| Open Elective | |
|---|---|
| 26CSO101 | Business Analytics |
| 26MEO101 | Industrial Safety |
| 26MEO103 | Composite Materials |
| 26MEO104 | Alternative Energy Sources |
| 26MEO105 | Computational Fluid Dynamics |
| 26CEO101 | Cost Management of Engineering Projects |
| 26EEO104 | Waste to Energy |
| 26PYO101 | History of Science and Technology |

****Students those who are going for Internship / Industrial project, may complete these courses through NPTEL/ MOOCs**

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**R26 (In line with AICTE Model Curriculum) with effect from AY 2026-27**

**M. Tech. (Computer Science and Engineering)**

**SEMESTER – IV**

| S. No | Course Code | Title of the Course | Scheme of Instruction | | | Scheme of Examination | | | Credits |
|---|---|---|---|---|---|---|---|---|---|
| | | | Hours per Week | | | Duration of SEE in Hours | Maximum Marks | | |
| | | | L | T | P/D | | CIE | SEE | |
| **DISSERATATION** | | | | | | | | | |
| 1. | 26CSC112 | Dissertation Phase-II | - | - | 32 | - | 100 | 100 | 16 |
| **Total** | | | **-** | **-** | **32** | **-** | **100** | **100** | **16** |

**L: Lecture** **D: Drawing** **CIE: Continuous Internal Evaluation**
**T: Tutorial** **P: Practical/Dissertation** **SEE-Semester End Examination**

| | CREDIT SUMMARY | | | |
|---|---|---|---|---|
| **SEMESTER** | **I** | **II** | **III** | **IV** |
| **CREDITS** | **16** | **17** | **19** | **16** |
| **Total :** | | | | **68** |

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**M.Tech. (Computer Science and Engineering)**

**AUDIT COURSES -1 & 2**

| S.No | Course Code | Title of the Course |
|---|---|---|
| 1. | 26EGA101 | English for research paper writing |
| 2. | 26CEA101 | Disaster mitigation and management |
| 3. | 26EEA101 | Sanskrit for Computational Thinking and Engineering Applications |
| 4. | 26ECA101 | Value education |
| 5. | 26EGA102 | Constitution of India |
| 6. | 26ADA101 | Pedagogy studies |
| 7. | 26EGA103 | Stress Management by Yoga |
| 8. | 26EGA104 | Personality Development through Life's Enlightenment Skills. |

# I-Semester
# and
# II-Semester
# Syllabus

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**M. Tech. (Computer Science and Engineering)**

**SEMESTER – I**

| S. No | Course Code | Title of the Course | Scheme of Instruction | | | Scheme of Examination | | | Credits |
|---|---|---|---|---|---|---|---|---|---|
| | | | Hours per Week | | | Duration of SEE in Hours | Maximum Marks | | |
| | | | L | T | P/D | | CIE | SEE | |
| **THEORY** | | | | | | | | | |
| 1. | 26CSC101 | Data Science and Big Data Analytics | 3 | - | - | 3 | 40 | 60 | 3 |
| 2. | 26CSC102 | Advanced Algorithms | 3 | - | - | 3 | 40 | 60 | 3 |
| 3. | 26CSExxx | Professional Elective-I | 3 | - | - | 3 | 40 | 60 | 3 |
| 4. | 26CSExxx | Professional Elective-II | 3 | - | - | 3 | 40 | 60 | 3 |
| 5. | 26xxxxxx | Audit Course-1 | 2 | - | - | 2 | - | 50 | Non Credit |
| **PRACTICAL** | | | | | | | | | |
| 6. | 26CSC103 | Advanced Algorithms Lab | - | - | 2 | - | 50 | - | 1 |
| 7. | 26CSExxx | Professional Elective-II Lab | - | - | 3 | - | 50 | - | 1.5 |
| 8. | 26CSC104 | Mini Project | - | - | 3 | - | 50 | - | 1.5 |
| **Total** | | | **14** | **-** | **8** | **-** | **310** | **290** | **16** |

**L: Lecture** **D: Drawing** **CIE: Continuous Internal Evaluation**
**T: Tutorial** **P: Practical/ Dissertation** **SEE-Semester End Examination**

| **Professional Elective-I** | |
|---|---|
| 26CSE101 | Soft Computing |
| 26CSE102 | Advanced Databases |
| 26CSE103 | Computer Vision and Image Processing |
| 26CSE104 | Software Project Management |
| 26CSE105 | Advanced Optimization Techniques |

| **Professional Elective-II** | |
|---|---|
| 26CSE106 | Deep Learning |
| 26CSE107 | Concurrent Programming |
| 26CSE108 | Data Visualization |
| 26CSE109 | Software Defined Networks |
| 26CSE110 | Network Security |

| **Professional Elective – II Lab** | |
|---|---|
| 26CSE111 | Deep Learning Lab |
| 26CSE112 | Concurrent Programming Lab |
| 26CSE113 | Data Visualization Lab |
| 26CSE114 | Software Defined Networks Lab |
| 26CSE115 | Network Security Lab |

**26CSC101**

## DATA SCIENCE AND BIG DATA ANALYTICS

| | |
|---|---|
| Instruction | 3 L Hours per Week |
| Duration of Semester End Examination | 3 Hours |
| Semester End Examination | 60 Marks |
| Continuous Internal Evaluation | 40 Marks |
| Credits | 3 |

**COURSE OBJECTIVES:** This course aims to

1. Provide fundamental knowledge of data science concepts, including data collection, preprocessing, exploratory data analysis, and ethical considerations for handling data.
2. Develop the ability to apply machine learning techniques and statistical methods for analyzing data, building predictive models, and evaluating their performance.
3. Equip students with skills in Big Data technologies and modern frameworks such as Hadoop and Apache Spark for scalable data storage, processing, and analytics.

**COURSE OUTCOMES:** After the completion of this course, the student will be able to

1. Apply data preprocessing techniques to handle missing values, noisy data, and perform basic data cleaning operations.
2. Evaluate and interpret visualizations such as heatmaps and pair plots to draw meaningful insights from data.
3. Apply machine learning algorithms to solve real-world problems and Analyze model performance
4. Use HDFS command-line interface and Hadoop file systems to store, retrieve, and manage large datasets and Analyze the working of MapReduce
5. Apply Spark Core concepts and RDD operations to perform distributed data processing tasks.

**CO-PO Articulation Matrix**

| PO / CO | PO1 | PO2 | PO3 | PO4 |
|---|---|---|---|---|
| **CO 1** | 3 | 2 | 2 | - |
| **CO 2** | 2 | 3 | 2 | - |
| **CO 3** | 3 | 3 | 3 | 1 |
| **CO 4** | 3 | 3 | 3 | 1 |
| **CO 5** | 3 | 3 | 3 | 2 |

1-Slightly, 2-Moderately, 3-Substantially

**UNIT-I**

**Foundations of Data Science:** Data Science lifecycle and CRISP-DM Model, Types of data and data sources, **Data collection:** APIs, scraping, sensors, Data quality metrics. Data preprocessing: Missing values, noise handling, Data warehousing and ETL pipelines, Data governance and data ethics basics.

**UNIT-II**

**Data Processing and Descriptive Analytics:** Descriptive statistics and distributions, Data cleaning and transformation, Outlier detection methods, Data transformation (normalization, scaling), Correlation and covariance analysis.

**Visualization techniques:** Histograms, boxplots, scatterplots, advanced visualization: Heatmaps, pair plots, Tools for EDA: Pandas, NumPy, Data storytelling and dash boarding.

**UNIT-III**

**Machine Learning for Data Science - Predictive Analytics:** Fundamentals: ML pipeline and types of ML. Supervised Learning: Linear Regression, Logistic Regression, Decision Trees, k-NN algorithm. Unsupervised Learning: K-Means clustering, Hierarchical clustering. Model Evaluation: Confusion matrix, Precision, Recall, F1-score, Cross-validation and model generalization, Bias-variance tradeoff.

**UNIT-IV**

**Big Data Architecture and Hadoop Ecosystem:** Introduction, Big Data Enabling Technologies, Hadoop Stack for Big Data. The Hadoop Distributed Files system: Overview, Hadoop File systems.

**MapReduce:** Overview, Developing a MapReduce Application, How MapReduce works, MapReduce Types and Formats, MapReduce Features, MapReduce Examples.

Introduction to Big Data Frameworks, Need for advanced frameworks beyond Hadoop, Limitations of MapReduce, Overview of modern big data processing frameworks

**UNIT-V**

**Big Data Analytics using Modern Frameworks:** Introduction to Apache Spark: Spark architecture, Components: Driver, Executor, Cluster Manager, Advantages over Hadoop MapReduce, Spark core and RDDs, RDD operations, Data processing with Spark.

**Introduction to Kafka:** Introduction, Event screaming and Kafka fundamentals, Kafka Architecture and Internal Mechanisms, Building Data Pipelines, Real-time streaming Process (Kafka Streams and KSQL DB)

## TEXT BOOKS:


1. David Dietrich, Barry Heller, and Beibei Yang, "Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data", 1st Edition, John Wiley & Sons, EMC education services, 2015.
2. Gwen Shapira et. All, "Kafka: The Definite Guide", 2nd Edition, O'Reilly Media, 2021.


## SUGGESTED READING:


1. Jules S. Damji, Brooke Wenig, Tathagata Das, Danny Lee, "Learning Spark: Lightning-Fast Data Analytics", 2nd Edition, O'Reilly, 2020.
2. Foster Provost, Tom Fawcet, "Data Science for Business - What you need to know about Data Mining and Data Analytic Thinking",1st Edition, O'Reilly Media Inc., 2013.
3. Tom White, "Hadoop: The Definitive Guide", 4th Edition, O'Reilly Media Inc, 2015.


## ONLINE RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc26_cs65/preview
2. https://elearn.nptel.ac.in/shop/nptel/machine-learning-for-engineering-and-science-applications/?v=13b5bfe96f3e
3. https://onlinecourses.nptel.ac.in/noc24_cs130/preview

**26CSC102**

## ADVANCED ALGORITHMS

| | |
|---|---|
| Instruction | 3 L Hours per Week |
| Duration of Semester End Examination | 3 Hours |
| Semester End Examination | 60 Marks |
| Continuous Internal Evaluation | 40 Marks |
| Credits | 3 |

**PREREQUISITES:** UG level course in Algorithm Design and Analysis

**COURSE OBJECTIVES:** This course aims to

1. Introduce advanced methods of choosing, designing and analyzing algorithms.
2. Familiarize with basic paradigms and data structures used to solve advanced algorithmic problems.
3. Understand different classes of problems concerning their computation difficulties.

**COURSE OUTCOMES:** After completion of this course, students will be able to

1. Identify and apply data structures, sorting, graph algorithms, and randomized methods to solve computational problems efficiently.
2. Apply the greedy paradigm and graph matching strategies to solve optimization and network problems.
3. Implement flow network algorithms and matrix computation techniques to analyze and solve advanced problems.
4. Construct dynamic programming solutions and apply modular arithmetic to solve classical optimization and interpolation problems.
5. Evaluate NP-hard problems using linear programming, approximation, and randomized strategies to develop near-optimal solutions.

**CO-PO Articulation Matrix**

| PO / CO | PO 1 | PO 2 | PO 3 | PO 4 |
|---|---|---|---|---|
| **CO 1** | 3 | 1 | 2 | 3 |
| **CO 2** | 3 | 1 | 2 | 3 |
| **CO 3** | 3 | 1 | 2 | 3 |
| **CO 4** | 3 | 1 | 2 | 3 |
| **CO 5** | 3 | 1 | 3 | 3 |

1-Slightly, 2-Moderately, 3-Substantially

**UNIT-I**

**Introduction to Data Structures:** Preliminary Data structures- Stack, Queue, Linked List, emphasis on correctness proof of the algorithm and time/space analysis, example of amortized analysis.

**Randomized Algorithms:** Introduction: Las Vegas vs Monte Carlo algorithms,; probability and expectation in algorithm analysis. Hiring problem, Randomized Quicksort, Universal Hashing. Data Structure Augmentation, Interval Trees.

**UNIT-II**

**Matroids:** Introduction to greedy paradigm, algorithm to compute a maximum weight maximal independent set. Application to MST.

**Graph Matching:** Algorithm to compute maximum matching. Characterization of maximum matching by augmenting paths, Edmonds' Blossom algorithm to compute augmenting path.

**UNIT-III**

**Flow-Networks:** Maxflow-Mincut theorem, Ford-Fulkerson Method to compute maximum flow, Edmonds-Karp maximum-flow algorithm.

**Matrix Computations:** Strassen's algorithm and introduction to divide and conquer paradigm, inverse of a triangular matrix, relation between the time complexities of basic matrix operations, LUP-decomposition.

**UNIT-IV**

**Shortest Path in Graphs:** Floyd-Warshall algorithm and introduction to dynamic programming paradigm- Optimal Binary Search Tree, 0/1 Knapsack Problem, Longest Common Subsequence, Matrix Chain Multiplication.

**Modulo Representation of integers/polynomials:** Chinese Remainder Theorem, Conversion between base representation and modulo-representation. Extension to polynomials. Application: Interpolation problem.

**UNIT-V**

**Linear Programming:** Geometry of the feasibility region and Simplex algorithm

**NP-completeness:** proof of NP-hardness and NP-completeness-Clique Problem, Vertex-Cover Problem, Subset-Sum Problem.

**Randomized Rounding:** LP relaxation and randomized rounding for approximation. Approximate Max-Cut via randomization.

## TEXT BOOKS:


1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, "Introduction to Algorithms", 3rd Edition, the MIT Press, 2009.
2. Sanjoy Dasgupta, Christos Papadimitriou, Umesh Vazirani, "Algorithms", 1st Edition, McGraw-Hill, 2006.


## SUGGESTED READING:


1. Alfred V. Aho, John E. Hopcroft, Jeffrey D. Ullman, "The Design and Analysis of Computer Algorithms", 1st Edition, Pearson Addison-Wesley Publication, 1974.
2. Jon Kleinberg, Eva Tardos, "Algorithm Design", 1st Edition, Pearson Addison-Wesley Publication, 2009.
3. Motwani, Raghavan, "Randomized Algorithms", 1st Edition, Cambridge Univ. Press 1995


## ONLINE RESOURCES:

1. https://nptel.ac.in/courses/106104019/
2. https://ocw.mit.edu/courses/6-046j-design-and-analysis-of-algorithms-spring-2015/
3. https://www.coursera.org/specializations/algorithms

**26CSE101**

## SOFT COMPUTING
**(Professional Elective-I)**

| | |
|---|---|
| Instruction | 3 L Hours per Week |
| Duration of Semester End Examination | 3 Hours |
| Semester End Examination | 60 Marks |
| Continuous Internal Evaluation | 40 Marks |
| Credits | 3 |

**PREREQUISITE**: UG level course in Basic knowledge of mathematics.

**COURSE OBJECTIVES:** This course aims to
1. Learn various types of soft computing techniques and their applications.
2. Acquire the knowledge of neural network architectures, learning methods and algorithms.
3. Understand Fuzzy logic, Genetic algorithms and their applications.

**COURSE OUTCOMES:** After completion of this course, students will be able to
1. Describe the basic models, evolution and terminology of Artificial Neural Networks, Fuzzy Logic, and Genetic Algorithms.
2. Design and implement supervised (Perceptron, Backpropagation) and unsupervised (Kohonen, ART) learning models for data classification and pattern recognition.
3. Evaluate Kohonen self-organzing maps, Adaptive Resonance Theory, Hopfield networks, and Bidirectional Associative Memory for pattern recognition.
4. Develop fuzzy expert decision-making systems using membership functions, fuzzy reasoning, and defuzzification techniques.
5. Design simple genetic algorithms for optimization and knowledge acquisition in machine learning applications.

**CO-PO Articulation Matrix**

| PO / CO | PO 1 | PO 2 | PO 3 | PO 4 |
|---|---|---|---|---|
| **CO 1** | 2 | - | - | - |
| **CO 2** | 2 | 2 | 1 | 2 |
| **CO 3** | 3 | 1 | - | 1 |
| **CO 4** | 1 | - | - | - |
| **CO 5** | 2 | 1 | 1 | 1 |

**UNIT-I**

**Introduction-Evolution of Computing:** Soft Computing Constituents, Conventional AI to Computational Intelligence, Hard vs Soft computing. Introduction to Fuzzy Logic, Fuzzy Membership Functions. Fuzzy Sets, Operations on Fuzzy Sets, Fuzzy Relations.

**UNIT-II**

**Fuzzy logic:** Membership Functions: Fuzzy Rules and Fuzzy Reasoning, Fuzzy Inference Systems, Defuzzification Techniques, Fuzzy Expert Systems, Fuzzy Decision Making.

**UNIT-III**

**Artificial Neural Networks**: Evolution of neural networks, Basic models of artificial neural network, important terminologies of ANNs. McCulloch-Pitts neuron, linear separability, Hebb network. **Supervised Learning Neural Networks**: Perceptron networks, Adaptive linear neuron (Adaline), Multiple Adaptive linear neuron (Madaline), Back propagation network.

**UNIT-IV**

**Unsupervised Learning Neural Networks:** Kohonen self organizing networks, Adaptive resonance theory. **Associate Memory Networks:** Bidirectional associative memory network, Hopfield networks.

**UNIT-V**

**Genetic algorithms:** Introduction to Genetic Algorithms (GA), Applications of GA in Machine Learning: Simple genetic algorithm, General genetic algorithm, Classification of genetic algorithm, Machine Learning Approach to Knowledge Acquisition.

## TEXT BOOKS:


1. S.N. Sivanandam & S.N. Deepa, "Principles of soft computing", 2nd Edition, Wiley publications, Wiley, 2011.
2. LiMin Fu, "Neural Networks in Computer Intelligence", 1st Edition, McGraw-Hill, 1994.


## SUGGESTED READING:


1. S. Rajasekaran & G.A. Vijayalakshmipai, "Neural Networks, Fuzzy logic & Genetic Algorithms, Synthesis & Applications", 1st Edition, PHI publication, 2008.
2. K.L.Du & M.N.S Swamy, "Neural Networks in a Soft Computing Framework", Springer International edition, 2008.
3. Goldberg, David E., "Genetic Algorithms in Search, Optimization and Machine Learning", 1st Edition, Addison Wesley, New Delhi, 2008.


## ONLINE RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc18_cs13/preview.
2. https://archive.nptel.ac.in/courses/106/105/106105173/

**26CSE102**

## ADVANCED DATABSES
**(Professional Elective-I)**

| | |
|---|---|
| Instruction | 3 L Hours per Week |
| Duration of Semester End Examination | 3 Hours |
| Semester End Examination | 60 Marks |
| Continuous Internal Evaluation | 40 Marks |
| Credits | 3 |

**PREREQUISITES:** UG level course DBMS and Relational Calculus.

**COURSE OBJECTIVES:** This course aims to
1. Introduce advanced and emerging database models including NoSQL and graph databases.
2. Explain internal query processing and optimization techniques in modern DBMS.
3. Study centralized, parallel, distributed and cloud database architectures.
4. Understand distributed transaction management and consistency models.
5. Explore performance tuning, indexing, and real-world database applications.

**COURSE OUTCOMES:** After the completion of this course, the student will be able to
1. Explain advanced data models (NoSQL, graph, spatial, semi-structured, vector and multimodal databases).
2. Estimate query processing costs and evaluate execution strategies.
3. Compare architectures including distributed, parallel, and cloud databases.
4. Analyze concurrency control and commit protocols in distributed systems.
5. Apply performance tuning and advanced indexing in real-world scenarios.

**CO-PO Articulation Matrix**

| PO / CO | PO 1 | PO 2 | PO 3 | PO 4 |
|---|---|---|---|---|
| **CO 1** | 2 | - | - | - |
| **CO 2** | 2 | - | - | - |
| **CO 3** | 2 | 1 | 1 | - |
| **CO 4** | 2 | 1 | 1 | - |
| **CO 5** | 2 | 1 | 1 | - |

1-Slightly, 2-Moderately, 3-Substantially

**UNIT-I**

**Complex Data types:**

**Semi-structured Data** -Overview of Semi-structured Data Models, JSON, XML, RDF Knowledge Graphs.

**NoSQL Databases**: Key-Value, Document, Column-family, Graph databases

**Object Orientation -** Object-Relational Database Systems, Object-Relational Mapping.

**Textual Data** -Keyword Queries, Relevance Ranking, Measuring Retrieval Effectiveness, Keyword Querying on Structured Data and Knowledge Graphs.

**Spatial Data-** Representation of Geometric Information, Design Databases, Geographic Data, Spatial Queries

**Vector Databases:** Introduction to vector data and embeddings, Similarity search (cosine similarity, Euclidean distance), Indexing techniques (ANN, HNSW, FAISS basics), Use cases: recommendation systems, semantic search, AI retrieval.

**Multi modal Data Management:** Introduction to multimodal data (text, image, audio, video), Data representation techniques for multimodal systems, Metadata and feature extraction, Storage and retrieval challenges..

**UNIT-II**

**Query Processing:** Overview, Measures of Query Cost, Selection Operation, Sorting, join Operation, Other Operations, Evaluation of Expressions, ++Query processing in the memory.

**Query Optimization:** Overview, Transformation of Relational Expressions, Estimating Statistics of Expression Results, Choice of Evaluation Plans, Materialized Views, Advanced topics in Query optimization.

**UNIT-III**

**Database-System Architectures:** Centralized Database Systems, Server System Architectures, Parallel Systems, Distributed Systems, Transaction Processing in Parallel and Distributed Systems, Cloud-Based Services.

**Parallel and Distributed Storage:** Data Partitioning, Dealing with Skew in Partitioning, Replication, Parallel Indexing, Parallel Key-Value Stores Cloud Databases & DBaaS, Data Partitioning, Replication, Big Data Storage Systems.

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**UNIT-IV**

**Parallel and Distributed Query Processing:** Parallel Sort, Parallel Join, Other Operations, Parallel Evaluation of Query Plans, Query Processing on Shared-Memory Architectures, Query Optimization for Parallel Execution, Parallel Processing of Streaming Data, Distributed Query Processing.

**Parallel and Distributed Transaction Processing**: Distributed Transactions, Commit Protocols, Concurrency Control in Distributed Databases, Replication, Extended Concurrency Control Protocols, Replication with Weak Degrees of Consistency, Coordinator Selection, Consensus in Distributed Systems. CAP Theorem, Consensus Algorithms

**UNIT-V**

**Advanced Application Development**: Performance Tuning, Performance Benchmarks, Other Issues in Application Development, Standardization, Distributed Directory Systems.

**Advanced Indexing Techniques:** Bloom Filter, Indexing of Spatial Data, B-Tree Variants, Lock Structured storage. LSM Trees, Spatial Indexing, Data Warehousing and OLAP.

**Multimodal Databases and AI Applications:** Multimodal query processing, Cross-modal retrieval (text-to-image, image-to-text), Applications in AI systems (chatbots, vision systems), Integration with machine learning pipelines.

## TEXT BOOKS:


1. Abraham Silberschatz, Henry F Korth, S Sudarshan, "Database System Concepts", 7th Edition, McGraw Hill International Edition, 2019.
2. Alex Petrov, "Data base Internals", 1st Edition, O'RElley, 2019.


## SUGGESTED READING:


1. Elmasri Navathe, Somayajulu, Gupta, "Fundamentals of Database Systems", 4th Edition, Pearson Education, 2006.
2. CJ Date, A Kannan, S Swamynathan, "An Introduction to Database Systems", 8th Edition, Pearson Education, 2006
3. Raghu Ramakrishnan, and Johannes Gehrke, "Database Management Systems", 3rd Edition, McGraw-Hill International, 2002.


## ONLINE RESOURCES:

1. https://www.db-book.com
2. https://www.coursera.org/learn/database-systems
3. https://cs186berkeley.net

**26CSE103**

## COMPUTER VISION AND IMAGE PROCESSING

**(Professional Elective-I)**

| | |
|---|---|
| Instruction | 3 L Hours per Week |
| Duration of Semester End Examination | 3 Hours |
| Semester End Examination | 60 Marks |
| Continuous Internal Evaluation | 40 Marks |
| Credits | 3 |

**PREREQUISITE:** UG level course in Linear Algebra and Probability.

**COURSE OBJECTIVES:** This course aims to

1. Understand the Fundamental Concepts Related To Multi-Dimensional Signal Processing.
2. Understand Feature Extraction algorithms.
3. Understand Visual Geometric Modeling and Stochastic Optimization.

**COURSE OUTCOMES:** After the completion of this course, the student will be able to

1. Understand the basic principles of image processing and its significance in real world.
2. Interpret and evaluate various approaches for image. Transformation, segmentation, and restoration.
3. Identify object, scene recognition and categorization algorithms for real time images.
4. Analyze images and videos for problems such as tracking and structure from motion.
5. Apply recovery of 3D structure of ill-posed scenes. Model various techniques to build computer vision applications.

**CO-PO Articulation Matrix**

| PO / CO | PO 1 | PO 2 | PO 3 | PO 4 |
|---|---|---|---|---|
| **CO 1** | 2 | 2 | 2 | - |
| **CO 2** | 2 | 2 | 2 | - |
| **CO 3** | 2 | 2 | 2 | - |
| **CO 4** | 3 | 2 | 2 | 1 |
| **CO 5** | 3 | 2 | 2 | 1 |

1-Slightly, 2-Moderately, 3-Substantially

**UNIT-I**

**Image Formation and Description:** Fundamental steps of image processing, the image model and Image acquisition, Sampling and quantization, Relationship between pixels. Sampling & Quantization, Elements of Digital Image Processing Systems.

**Image Transforms:** Digital Image Transforms - Fourier Transform, Extension to 2D.Properites of Fourier transformations.

**UNIT-II**

**Image Enhancements:** Histogram Equalization, Image Smoothing, Image Sharpening, Edge Detection.

**Segmentation:** Active contours, Split and merge, Mean shift and mode finding, Normalized cuts. Feature-based alignment: 2D and 3D feature-based alignment, Pose estimation.

**UNIT-III**

**Structure from motion:** Triangulation, Two-frame structure from motion, Factorization, Bundle adjustment, constrained structure and motion.

**Dense motion estimation:** Translational alignment, parametric motion, Spline-based motion, Optical flow,Layered motion.

**UNIT-IV**

**Recognition:** Object detection, Face recognition, Instance recognition, Category recognition, Context and scene understanding.

**UNIT - V**

**3D Reconstruction:** Shape from X, Active range finding, Surface representations, Point-based representations, volumetric representations, Model-based reconstruction.

## TEXT BOOKS:

1. R. C. Gonzalez and R. E. Woods "Digital Image Processing", 3rd Edition, Addison Wesley 2008.
2. Richard Szeliski, "Computer Vision: Algorithms and Applications" 1st Edition, Springer-Verlag London Limited2011.

## SUGGESTED READING:

1. Robert J. Schallkoff, "Pattern Recognition: Statistical. Structural and Neural Approaches", 1st Edition, John Wileyand Sons, 1992.
2. D. A. Forsyth and J. Ponce, "Computer Vision: A Modern Approach", 1st Edition, Pearson Education; 2003.
3. R. Hartley and A. "Zisserman, "Multiple View geometry", 2nd Edition, Cambridge University Press, 2004.

## ONLINE RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc18_ee40.
2. CV online: http://homepages.inf.ed.ac.uk/rbf/CVonline.
3. Computer Vision Homepage: http://www2.cs.cmu.edu/afs/cs/project/ cil/ftp/ html/vision.html.

**26CSE104**

## SOFTWARE PROJECT MANAGEMENT
**(Professional Elective-I)**

| | |
|---|---|
| Instruction | 3 L Hours per Week |
| Duration of Semester End Examination | 3 Hours |
| Semester End Examination | 60 Marks |
| Continuous Internal Evaluation | 40 Marks |
| Credits | 3 |

**PREREQUISITE**: Software Engineering.

**COURSE OBJECTIVES:** This course aims to
1. Analyze software project life cycle models, management frameworks, and modern practices such as Agile, DevOps, and automation.
2. Apply cost estimation techniques, software economics, and design effective project planning, scheduling, and risk management strategies.
3. Evaluate software quality using metrics and implement process improvement models for better project outcomes.

**COURSE OUTCOMES:** After the completion of this course, the student will be able to
1. Analyze software lifecycle models, management processes, and project frameworks.
2. Evaluate and apply advanced cost estimation and software economics models.
3. Design project planning, scheduling, and risk management strategies.
4. Analyze software quality, metrics, and configuration management techniques.
5. Integrate Agile, DevOps, automation, and emerging trends in project management.

**CO-PO Articulation Matrix**

| PO / CO | PO 1 | PO 2 | PO 3 | PO 4 |
|---|---|---|---|---|
| **CO 1** | 1 | 1 | 1 | 1 |
| **CO 2** | 2 | 1 | 2 | 2 |
| **CO 3** | 2 | 1 | 2 | 2 |
| **CO 4** | 1 | 1 | 3 | 2 |
| **CO 5** | 1 | 1 | 3 | 2 |

1-Slightly, 2-Moderately, 3-Substantially

**UNIT- I**

**Advanced Software Project Management & Economics:** Limitations of Conventional Software Management, Lifecycle Models: Waterfall, Spiral, Iterative;
Agile Software Management Process Framework: Phases, Artifacts, Workflows, Checkpoints, Software Economics: Cost drivers, productivity, Return on Investment (ROI), Process improvement: Lean, Six Sigma.

**UNIT-II**

**Advanced Cost Estimation & Financial Models:** Estimation Challenges in Large Systems, Algorithmic Models: COCOMO II (detailed), Function Point Analysis, Software Life Cycle Management Model (SLIM) Model, Machine Learning-based Estimation (intro), financial related Concepts: Activity-Based Costing, Economic Value Added (EVA), Balanced Scorecard.

**UNIT-III**

**Software Quality & Metrics Engineering :** Software Quality Models: ISO, CMMI, Software Quality Assurance (SQA), Software Quality Metrics: Product metrics, Process metrics, Complexity metrics (Halstead), Defect Management and Reliability Models, Software Configuration Management (SCM).

**UNIT-IV**

**Project Planning, Risk & Process Workflows:** Work Breakdown Structure (WBS), Scheduling Techniques: Program Evaluation and Review Technique (PERT), Critical Path Method (CPM), Agile planning, Risk Management: Identification, Analysis, Prioritization, Risk Mitigation & Monitoring, FMEA (Failure Mode and Effects Analysis), Project Monitoring and Control.

**UNIT-V**

**Project Evaluation, DevOps & Emerging Trends :** Project Evaluation Techniques: Cost-Benefit Analysis, Cash Flow Forecasting, Risk Evaluation, Strategic and Technical Assessment, DevOps and Continuous Integration/Deployment, Agile at Scale (Scaled Agile Framework-SAFe overview), Global Software Development Challenges, People-centric process models.

## TEXT BOOKS:


1. Bob Hughes & Mike Cotterell – Software Project Management, 6th Edition, McGraw Hill, 2018.
2. Walker Royce – Software Project Management: A Unified Framework, 2015 reprint edition, Addison-Wesley, 2015


## SUGGESTED READING:


1. Roger S. Pressman – Software Engineering, Latest Edition: 9th Edition, McGraw-Hill, 2023.
2. Pankaj Jalote – Software Project Management in Practice, 2016 reprint Edition Pearson India, Addison-Wesley, 2016
3. PMI – PMBOK Guide, 8th Edition, Project Management Institute (PMI), 2026.


## ONLINE RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc19_cs70/preview
2. coursera.org/courses?query=software%20project%20management

**26CSE105**

## ADVANCED OPTIMIZATION TECHNIQUES

**(Professional Elective-I)**

| | |
|---|---|
| Instruction | 3 L Hours per Week |
| Duration of Semester End Examination | 3 Hours |
| Semester End Examination | 60 Marks |
| Continuous Internal Evaluation | 40 Marks |
| Credits | 3 |

**PREREQUISITE**: Operations Research, Engineering Mathematics, Linear Algebra.

**COURSE OBJECTIVES:** This course aims to

1. Understand the fundamentals of linear programming and dynamic programming, and apply them to engineering optimization problems.
2. Learn classical and numerical optimization techniques for single and multi-variable problems with and without constraints.
3. Explore modern evolutionary algorithms including Genetic Algorithms, Genetic Programming, and Fuzzy Systems.

**COURSE OUTCOMES:** After the completion of this course, the student will be able to

1. Explain the fundamental concepts of Linear Programming and Dynamic Programming and solve related engineering problems.
2. Apply classical optimization techniques and numerical methods.
3. Describe working principles of Ant Colony Optimization, and Particle Swarm Optimization and apply them to real worls problems
4. Formulate and solve Integer Programming problems.
5. Model and solve optimization problems arising in Data Mining and Intelligent System Design.

**CO-PO Articulation Matrix**

| PO / CO | PO 1 | PO 2 | PO 3 | PO 4 |
|---|---|---|---|---|
| **CO 1** | 2 | 2 | 1 | 2 |
| **CO 2** | 2 | 2 | 1 | 2 |
| **CO 3** | 3 | 2 | 2 | 2 |
| **CO 4** | 2 | 1 | 2 | 1 |
| **CO 5** | 3 | 2 | 1 | 2 |

1-Slightly, 2-Moderately, 3-Substantially

**UNIT - I**

**Linear Programming (LP):** Revised Simplex Method, Dual Simplex Method, and Sensitivity Analysis.

**Dynamic Programming (DP):** Multistage decision processes, concepts of sub-optimization, recursive relation calculus method and tabular method, LP as a special case of DP.

**UNIT - II**

**Classical Optimization Techniques**: Single variable optimization without constraints, multi-variable optimization without constraints, multi-variable optimization with constraints, method of Lagrange multipliers, Kuhn-Tucker conditions.

**Numerical Methods for Optimization:** Nelder-Mead simplex search method, gradient of a function, steepest descent method, Newton's method.

**UNIT - III**

**Evolutionary Computation for Optimization:** Introduction to population-based metaheuristics and their role in solving complex optimization problems.

**Ant Colony Optimization (ACO):** Pheromone update rules, construction graph, parameter tuning; applications to Travelling Salesman Problem and routing problems in networks.
**Particle Swarm Optimization (PSO):** Swarm intelligence concepts, velocity and position update equations, inertia weight, global and local best.

**UNIT – IV**
**Integer Programming:** Integer Programming using LPP, Gomory's cutting plane method, Balas' algorithm for zero-one programming, Branch-and-Bound method.
**Combinatorial Optimization Concepts:** Discrete optimization problems and their relevance in computer science.

**UNIT – V**
**Data fitting and Regression:** Formulation of curve fitting as an optimization problem, least squares regression, polynomial fitting, and weighted regression, application to model calibration and experimental data analysis.
**Data Mining:** Optimization in clustering, objective function formulation, optimization-based feature selection and attribute weighting, application to pattern recognition and knowledge discovery tasks.
**Intelligent System Design:** Optimization of neural network architecture and training parameters, optimum design of fuzzy rule bases, optimization-based classifier and expert system design.

## TEXT BOOKS:


1. S. S. Rao, "Engineering Optimization: Theory and Practice", 4th Edition, John Wiley & Sons, Inc., Hoboken, New Jersey, 2009.
2. Kalyanmoy Deb, "Optimization for Engineering Design: Algorithms and Examples", 2nd Edition, Prentice Hall of India (PHI Learning), New Delhi, 2012.


## SUGGESTED READING:


1. David E. Goldberg, "Genetic Algorithms in Search, Optimization, and Machine Learning", 1st Edition, Addison-Wesley Publishing Company, 1989.
2. Frederick S. Hillier and Gerald J. Lieberman, "Introduction to Operations Research", 10th Edition, McGraw-Hill Education (India Edition / TMH), 2015.
3. Jasbir S. Arora, "Introduction to Optimum Design", 4th Edition, Academic Press (Elsevier), 2017.


## ONLINE RESOURCES:

1. https://nptel.ac.in/courses/112104209 — Optimization (NPTEL, IIT Kharagpur)
2. https://www.youtube.com/watch?v=wEdZLKMMZ8o&list=PLwdnzlV3ogoXKKb9nABDWYltTDgi37lYD
3. https://www.youtube.com/watch?v=GMTvoKRfxQw&list=PLGbjwqYC00hsy6XGalOBAphm2tdeLbgK0

**26CSE106**

## DEEP LEARNING
**(Professional Elective-II)**

| | |
|---|---|
| Instruction | 3 L Hours per Week |
| Duration of Semester End Examination | 3 Hours |
| Semester End Examination | 60 Marks |
| Continuous Internal Evaluation | 40 Marks |
| Credits | 3 |

**PREREQUISITE:** UG level Course in Artificial Intelligence and Machine Learning.

**COURSE OBJECTIVES:** This course aims to
1. Learn the fundamentals of deep learning and the main research activities in this field.
2. Acquire the knowledge of Deep learning methods, models, Optimizations, Regularizations and algorithms.
3. Understand CNN, RNN, Transformers and GANs along with their applications.

**COURSE OUTCOMES:** After the completion of this course, the student will be able to
1. Understand various optimization techniques used in deep learning.
2. Analyze various Auto encoders and Regularization Techniques.
3. Design and develop various Convolution Neural Networks architectures.
4. Analyze various RNNs and Encoder Decoder Models.
5. Understand the importance of Transformers, GANs to develop real-time applications.

**CO-PO Articulation Matrix**

| PO / CO | PO 1 | PO 2 | PO 3 | PO 4 |
|---|---|---|---|---|
| **CO 1** | 3 | 3 | 2 | - |
| **CO 2** | 2 | 2 | 2 | 2 |
| **CO 3** | 2 | 2 | - | 2 |
| **CO 4** | 2 | 2 | 2 | 2 |
| **CO 5** | 3 | 2 | 2 | 1 |

1-Slightly, 2-Moderately, 3-Substantially

**UNIT-I**

**Introduction**: Introduction, Historical Trends in Deep Learning.

**Optimization**: Gradient Descent (GD), Momentum Based GD, Nesterov Accelerated GD, Stochastic GD, AdaGrad, RMSProp, Adam.

**UNIT-II**

**Autoencoders:** relation to PCA, Regularization in autoencoders, Denoising autoencoders, Sparse autoencoders, Contractive autoencoders, **Regularization:** Bias Variance Tradeoff, L2 regularization, Early stopping, Dataset augmentation, Parameter sharing and tying, Injecting noise at input, Ensemble methods, Dropout, Better activation functions, Better weight initialization methods, Batch Normalization

**UNIT-III**

**Convolutional Neural Network**: The Convolution Operation, Motivation, Pooling, Convolution and Pooling as an Infinitely Strong Prior, Variants of the Basic Convolution Function, Structured Outputs, Data Types. AlexNet, VGGNet, GoogLeNet, ResNet, MobileNet, Guided Backpropagation.

**Object Detection:** YOLO, R-CNN overview

**UNIT-IV**

**Recurrent Neural Networks**, Backpropagation through time (BPTT), Vanishing and Exploding Gradients, Truncated BPTT, GRU, LSTMs Encoder Decoder Models, Attention Mechanism, Attention over images

**UNIT-V**

**Transformers:** Introduction to Transformers, BERT, Introduction to Vision Transformers.

**Generative Adversarial Networks (GANs):** Introduction, Discriminator, Generator, Activation, Common activation functions for GANs, BCE loss, Conditional GANs, Controllable generation, real life GANs. Introduction to Deep Reinforcement Learning

## TEXT BOOKS:


1. Ian Goodfellow, Yoshua Bengio and Aaron Courville, "Deep Learning", 1st Edition, MIT Press, 2016.
2. Ganguly Kuntal, "Learning generative adversarial networks: next-generation deep learning simplified", 1st Edition, Packt Publishing, 2017.


## SUGGESTED READING:


1. Umberto Michelucci "Applied Deep Learning. A Case-based Approach to Understanding Deep Neural Networks", 2nd Edition, Apress, 2022.
2. Giancarlo Zaccone, Md. Rezaul Karim, Ahmed Menshawy "Deep Learning with TensorFlow: Explore neural networks with Python", 2nd Edition, Packt Publisher, 2018.
3. Lewis Tunstall, Leandro von Werra, and Thomas Wolf, "Natural Language Processing with Transformers", O'Reilly Media Inc., Revised Edition, 2022


## ONLINE RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc18_cs41/
2. https://onlinecourses.nptel.ac.in/noc22_cs22/

**26CSE107**

## CONCURRENT PROGRAMMING
**(Professional Elective-II)**

| | |
|---|---|
| Instruction | 3 L Hours per Week |
| Duration of Semester End Examination | 3 Hours |
| Semester End Examination | 60 Marks |
| Continuous Internal Evaluation | 40 Marks |
| Credits | 3 |

**PREREQUISITE**: Operating Systems, Basics of Object Oriented Programming.

**COURSE OBJECTIVES:** This course aims to
1. Familiarize the principles for programming secure, reliable, and robust software in a multi-threaded or multi-process environment.
2. Examine the potential run-time problems arising from the concurrent operation of many separate tasks.
3. Make understand the synchronization primitives and develop correct concurrent programs using appropriate programming models.

**COURSE OUTCOMES:** After the completion of this course, the student will be able to
1. Understand and reason about concurrency and concurrent objects.
2. Analyze the concurrent programming algorithms.
3. Interpret concurrent objects for solving problems that require synchronization.
4. Implement the locking and non-blocking mechanisms.
5. Develop the mechanisms for communication and coordination among concurrent processes.

**CO-PO Articulation Matrix**

| PO / CO | PO 1 | PO 2 | PO 3 | PO 4 |
|---|---|---|---|---|
| **CO 1** | 2 | - | 1 | 1 |
| **CO 2** | 3 | - | 2 | 1 |
| **CO 3** | 2 | - | 1 | 2 |
| **CO 4** | 3 | - | 2 | 1 |
| **CO 5** | 3 | - | 1 | 2 |

1-Slightly, 2-Moderately, 3-Substantially

**UNIT – I**

**Introduction:** Shared Objects and Synchronization, A Fable, Properties of Mutual Exclusion, The Moral, The Producer–Consumer Problem, the Harsh Realities of Parallelization.

Mutual Exclusion - Time, Critical Sections, 2-Thread Solutions, The Peterson Lock, The Filter Lock, Lamport's Bakery Algorithm.

**UNIT - II**

**Concurrent Objects:** Concurrency and Correctness, Sequential Objects, Quiescent consistency, Sequential Consistency, Linearizability, Linearization Points, Formal Definitions Linearizability, Compositional Linearizability, The Nonblocking Property, Progress conditions, Dependent Progress Conditions, The Java Memory Model, Locks and synchronized Blocks, Volatile Fields, Final Fields.

**UNIT – III**

**Synchronization Operations:** Synchronization Operations, Consensus Numbers, Consensus Protocols, The compareAndSet() Operation, Introduction Universality, A Lock-Free Universal, Construction Wait- Free Universal Construction, Spin Locks , Test-And-Set Locks

**UNIT-IV**

**Linked Lists:** The Role of Locking, Introduction, List-Based Sets, Concurrent Reasoning, Coarse-Grained Synchronization, Fine-Grained Synchronization, Optimistic Synchronization, Lazy Synchronization, Non-Blocking Synchronization

**UNIT-V**

**Concurrent Queues and the ABA Problem:** Concurrent Queues and the ABA Problem, Concurrent Stacks and Elimination, Transactional Memories

**TEXT BOOKS:**

1. Maurice Herlihy, Nir Shavit, Victor Luchangco, Michael Spear, "The Art of Multiprocessor Programming", Paperback 2nd Edition, Morgan Kaufmann,2020.
2. Michal Raynal, "Concurrent Programming: Algorithms, Principles, and Foundations", 1st Edition, Springer Berlin, Heidelberg. 2015.

**SUGGESTED READING:**

1. Michel Charpentier, "Functional and Concurrent Programming: Core Concepts and Features", 1st Edition Addison-Wesley, 2022.
2. Maurice Herlihy and Nir Shavit, "The Art of Multiprocessor Programming", 1st Edition, Morgan Kaufmman Publishers, 2012.
3. Brian Goetz, Tim Peierls, Joshua Block, Joseph Bow beer, David Holmes and Doug Lea, "Java Concurrency in Practice", 1st Edition, Addison Wesley, 2006.

## ONLINE RESOURCES:

1. Elsevier Science -The Art of Multiprocessor Programming, Morgan Kaufmann, September 8, 2020 ISBN: 9780123914064
2. https://www.researchgate.net/publication/213876653_The_Art_of_Multiprocessor_Programming #fullTextFileContent
3. The Art of Multiprocessor Programming DOI: 10.1145/1146381.1146382 Source DBLP, Publisher: Elsevier, Inc.
4. Concurrent Programming: Algorithms, Principles, and Foundations | SpringerLink

**26CSE108**

## DATA VISUALIZATION
**(Professional Elective-II)**

| | |
|---|---|
| Instruction | 3 L Hours per Week |
| Duration of Semester End Examination | 3 Hours |
| Semester End Examination | 60 Marks |
| Continuous Internal Evaluation | 40 Marks |
| Credits | 3 |

**PREREQUISITE:** Python Programming

**COURSE OBJECTIVES:** This course aims to
1. Focus on principles of effective data visualization.
2. Understand advanced data representation techniques.
3. Apply modern visualization tools and storytelling concepts.
4. Design interactive and multi-dimensional visualizations.

**COURSE OUTCOMES:** After the completion of this course, the student will be able to
1. Apply principles of data encoding and visual perception.
2. Design effective visual representations for complex data.
3. Analyze relationships using advanced visualization techniques.
4. Create interactive and multi-dimensional visualizations.
5. Interpret and communicate insights using visual storytelling.

**CO-PO Articulation Matrix**

| PO / CO | PO 1 | PO 2 | PO 3 | PO 4 |
|---|---|---|---|---|
| **CO 1** | 3 | 3 | 1 | 1 |
| **CO 2** | 3 | 3 | 1 | 1 |
| **CO 3** | 3 | 2 | 3 | 2 |
| **CO 4** | 3 | 1 | 3 | 1 |
| **CO 5** | 3 | 1 | 3 | 2 |

1-Slightly, 2-Moderately, 3-Substantially

**UNIT-I**

**Foundations of Data Visualization and Visual Perception** Introduction to Data Visualization Definition, objectives, and scope, Role in data science and decision-making, Evolution of data visualization, Types of Data , Data Preprocessing for Visualization Data cleaning.Data Abstraction and Visual Encoding Marks.Proximity, Similarity, Continuity Closure, Pre-attentive processing. Data-to-Visual Mapping, Choosing appropriate visual encodings.

**UNIT-II**

**Data Representation and Visualization Techniques** Visualization of Quantities, Bar charts, column charts, Dot plots Area charts. Visualization of Distributions, Histograms, Box plots, Violin plots, Density plots. Visualization of Proportions, Pie charts and limitations Stacked bar charts, Tree maps. Multivariate Data Visualization, Bubble charts, Parallel coordinates ,Radar chars. Time-Series Visualization, Line plots, Seasonal decomposition, Moving averages.Geospatial Visualization Choropleth maps, Symbol maps, Basics of map projections.

**UNIT-III**

**Visualization of Relationships and Advanced Analysis Relationship Visualization, Combining Dataset**s, Working with Time Series, High-Performance functions - query() and eval().Scatter plots, Bubble plots, Regression lines. Correlation Analysis, Correlation coefficients, Heatmaps, Scatter matrix. Trend Analysis Time trends Forecast visualization basics. High-Dimensional Data Visualization

Dimensionality reduction PCA (conceptual),t-SNE .Projection techniques. Network and Graph Visualization Nodes and edges, Social network graphs, Tree structures.

**UNIT-IV**

**Dashboard Design & Interactive Visualization Dashboard Fundamentals Definition and purpose, Types,** Dashboard Design Principles , Key Performance Indicators (KPIs) .Definition and importance KPI selection and representation. Interactive Visualization Filters and drill-down, Tooltips and highlighting, linked views. Visualization Tools Concepts of: Power BI, Tableau, Plotly.

**UNIT-V**

**Advanced Concepts & Visual Storytelling Visual Storytelling**, Narrative structure, Data storytelling techniques, Context and audience. Visual Analytics, Combining analytics and visualization, Decision support systems. Visualization of Uncertainty Error bars, Confidence intervals, Probabilistic visualization. Ethical Issues in Visualization, Misleading graphs, Data manipulation, Bias in visualization. Big Data & Real-Time Visualization, Challenges in large datasets, Streaming data visualization. Emerging Trends AI-assisted visualization, Multimodal visualization, Augmented and virtual reality.

## TEXT BOOKS:


1. Claus O. Wilke, "Fundamentals of Data Visualization", 1st Edition, O'Reilly Media, 2019.
2. Jake Vander Plas, "Python Data Science Handbook", 1st Edition, O'Reilly Media, 2016.


## SUGGESTED READING:


1. Samir Madhavan, "Mastering Python for Data Science", 1st Edition, Packt Publishing, 2015.
2. Wes McKinney, "Python for Data Analysis: Data Wrangling with Pandas, NumPy, and Jupyter", 3rd Edition, O'Reilly Media, 2022.
3. Cole Nussbaumer Knaflic, "Storytelling with Data", 1st Edition, Wiley, 2015.


## ONLINE RESOURCES:

1. NumPy User Guide – https://numpy.org/doc/stable/user/index.html
2. Pandas Documentation – https://pandas.pydata.org/
3. Coursera – Data Analysis with Python – https://www.coursera.org/learn/data-analysis-with-python
4. GitHub – Claus Wilke Data Visualization Resources – https://github.com/clauswilke/dataviz
5. Matplotlib Documentation – https://matplotlib.org/stable/contents.html
6. Seaborn Documentation – https://seaborn.pydata.org/
7. Microsoft Power BI Learning – https://learn.microsoft.com/en-us/power-bi/Tableau Learning Resources – https://www.tableau.com/learn

**26CSE109**

## SOFTWARE DEFINED NETWORKS
**(Professional Elective-II)**

| | |
|---|---|
| Instruction | 3 L Hours per Week |
| Duration of Semester End Examination | 3 Hours |
| Semester End Examination | 60 Marks |
| Continuous Internal Evaluation | 40 Marks |
| Credits | 3 |

**PREREQUISITES**: Web Technology, Computer networks, Cloud Computing.

**COURSE OBJECTIVES:** This course aims to
1. Understand the concepts of software defined networks.
2. Learn the interface between networking devices and the software controlling them.
3. Know about SDN in data centers.
4. Explore modern approaches like Openflow, Openstack.

**COURSE OUTCOMES:** After the completion of this course, the student will be able to
1. Differentiate between traditional networks and software defined networks.
2. Understand advanced and emerging networking technologies.
3. Learn how to use SDN controllers to perform complex networking tasks.
4. Demonstrate the skills to do advanced networking research and programming.
5. Apply the knowledge on SDN and security measures to solve real world problems.

**CO-PO Articulation Matrix**

| PO / CO | PO 1 | PO 2 | PO 3 | PO 4 |
|---|---|---|---|---|
| **CO 1** | 3 | 2 | - | - |
| **CO 2** | 3 | 1 | - | - |
| **CO 3** | 3 | 2 | - | 2 |
| **CO 4** | - | 2 | 3 | 2 |
| **CO 5** | - | - | 2 | 3 |

1-Slightly, 2-Moderately, 3-Substantially

**UNIT-I**

**Introduction:** Basic packet, Switching terminology, Historical background, The modern Data Center Traditional switch architecture, Autonomous and dynamic forwarding Tables, Open source and technological shifts, Evolution of switches and Control plane, Cost SDN Implications for research and innovation, Data Center Innovation, Data Center needs, The evolution of networking technology.

**UNIT-II**

**SDN and Open Flow Specification:** Fundamental characteristics of SDN, SDN operation, SDN Devices, SDN Controller, SDN applications, Alternate SDN methods, Open Flow Overview, Open Flow 1.0 and Open Flow basics, Open Flow 1.1 additions, Open Flow 1.2 additions, Open Flow 1.3 additions, Open Flow limitations.

**UNIT-III**

**SDN in Data Centers and Other Environment:** Data Center definition, Data Center demands, Tunneling technologies for the Data Center, Path technologies in the Data Center, Ethernet fabrics in the Data Center, SDN Use Cases in the Data Center, Open SDN vs Overlays in the Data Center, Real World Data Center implementations.

**UNIT-IV**

**SDN Applications and Open-Source Perspectives:** SDN in other environments, Wide Area Networks, Service provider and carrier networks, Campus networks, Hospitality networks, Mobile network, Reactive versus proactive applications, Analyzing simple SDN Applications, A simple reactive Java application, Background on controllers, Using the Floodlight controller, using the Cisco XNC Controller, Switch considerations, Creating network virtualization tunnels.

**UNIT-V**

**SDN Security Challenges**: Characteristics of SDN, Security analysis and potential attacks in SDN, Solutions to the security issues in SDN, Network security enhancement using the SDN Framework, Issues and Challenges. SDN applications, Orchestration and network virtualization, Simulation and testing, Tools, Open Stack.

## TEXT BOOKS:


1. Paul Goransson and Chuck Black, "Software Defined Networks: A Comprehensive Approach", 1st Edition, Morgan Kaufmann Publications, 2014.
2. S. Scott-Hayward, S. Natarajan and S. Sezer, "A Survey of Security in Software Defined Networks," in IEEE Communications Surveys & Tutorials, vol. 18, no. 1, pp. 623-654, First quarter 2016.


## SUGGESTED READING:


1. Thomas D. Nadeau and Ken Gray, "SDN - Software Defined Networks", 1st Edition, O'Reilly Media, 2013.
2. Siamak Azodolmolky, "Software Defined Networking with OpenFlow", 1st Edition, Packt Publishing, 2013
3. Feamster, Nick, Jennifer Rexford, and Ellen Zegura, "The road to SDN: an intellectual history of Programmable networks." ACM SIGCOMM Computer Communication Review, Volume 44, Number 2, 2014.


## ONLINE RESOURCES:

1. https://opennetworking.org/sdn-definition/
2. https://www.javatpoint.com/software-defined-networking-sdn-benefits-and-challenges-of-network-virtualization
3. https://www.cloudflare.com/en-in/learning/network-layer/what-is-sdn/

**26CSE110**

## NETWORK SECURITY
**(Professional Elective-II)**

| | |
|---|---|
| Instruction | 3 L Hours per Week |
| Duration of Semester End Examination | 3 Hours |
| Semester End Examination | 60 Marks |
| Continuous Internal Evaluation | 40 Marks |
| Credits | 3 |

**PREREQUISITE:** Basics of Computer Networks, Cryptography fundamentals

**COURSE OBJECTIVES:** This course aims to
1. Provide fundamental understanding of network security concepts and cryptographic techniques.
2. Analyze different types of network attacks and corresponding defense mechanisms.
3. Understand security protocols used in networks such as SSL/TLS, IPsec, and VPNs.
4. Explore system security including firewalls, intrusion detection systems, and authentication mechanisms.
5. Introduce advanced topics such as cloud security, IoT security, and blockchain security.

**COURSE OUTCOMES:** After the completion of this course, the student will be able to
1. Explain principles of network security and cryptographic techniques.
2. Analyze various network attacks and apply appropriate countermeasures.
3. Evaluate security protocols for secure communication.
4. Design secure systems using firewalls, IDS/IPS, and authentication techniques.
5. Assess emerging trends in cybersecurity including IoT and cloud security.

**CO-PO Articulation Matrix**

| PO / CO | PO 1 | PO 2 | PO 3 | PO 4 |
|---|---|---|---|---|
| **CO 1** | 3 | 3 | 3 | 3 |
| **CO 2** | 3 | 3 | 3 | 3 |
| **CO 3** | 3 | 3 | 3 | 3 |
| **CO 4** | 3 | 3 | 3 | 3 |
| **CO 5** | 3 | 3 | 3 | 3 |

1-Slightly, 2-Moderately, 3-Substantially

**UNIT-I**

**Introduction to Network Security & Cryptography:** Security goals: Confidentiality, Integrity, availability.

**Security attacks:** Passive and Active attacks. Cryptography basics, Symmetric key cryptography (DES, AES)

Asymmetric cryptography (RSA, ECC), Hash functions and Message Authentication Codes.

**UNIT-II**

**Network Attacks and Defense Mechanisms:** Types of attacks: DoS/DDoS, Man-in-the-Middle, Replay attacks Phishing and spoofing, Malware: Virus, Worm, Trojan, Network scanning and vulnerability analysis. Countermeasures and secure practices

**UNIT - III**

**Security Protocols:** Secure communication principles, SSL/TLS protocol, IP Security (IPsec), Secure Shell (SSH).

Email security (PGP, S/MIME), Wireless security (WEP, WPA, WPA2, WPA3)

**UNIT - IV**

**System Security:** Firewalls: Types and configurations, Intrusion Detection and Prevention Systems (IDS/IPS), Authentication mechanisms (Passwords, Biometrics, MFA), Access control models (DAC, MAC, RBAC), Security policies and risk management

**UNIT - V**

**Network Security Advances:** Cloud security fundamentals, IoT security challenges, Blockchain security basics, Cyber laws and ethics, Case studies in cybersecurity incidents

## TEXT BOOKS:

1. William Stallings, "Network Security Essentials", 6th Edition, Pearson, 2017.
2. Charlie Kaufman, Radia Perlman, Mike Speciner, "Network Security: Private Communication in a Public World", 2nd Edition Prentice Hall.

## SUGGESTED READING:

1. Behrouz A. Forouzan, "Cryptography and Network Security", 3rd Edition, McGraw Hill, 2007.
2. Atul Kahate, "Cryptography and Network Security", 3rd Edition, McGraw Hill, 2013.
3. Eric Cole, "Network Security Bible", 2nd Edition, Wiley, 2011.

## ONLINE RESOURCES:

1. NPTEL – Network Security Courses
2. https://www.coursera.org (Cybersecurity Specializations)
3. https://nptel.ac.in

**CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY**
**R26 (In line with AICTE Model Curriculum) with effect from AY 2026-27**

**M.Tech. (Computer Science and Engineering)**

**AUDIT COURSES -1 & 2**

| S.No | Course Code | Title of the Course |
|---|---|---|
| 9. | 26EGA101 | English for Research Paper Writing |
| 10. | 26CEA101 | Disaster Mitigation and Management |
| 11. | 26EEA101 | Sanskrit for Computational Thinking and Engineering Applications |
| 12. | 26ECA101 | Value Education |
| 13. | 26EGA102 | Constitution of India |
| 14. | 26ADA101 | Pedagogy Studies |
| 15. | 26EGA103 | Stress Management by Yoga |
| 16. | 26EGA104 | Personality Development through Life's Enlightenment Skills. |

**26EGA101**

## ENGLISH FOR RESEARCH PAPER WRITING

**(Audit Course I and II - Common to all branches)**

| | |
|---|---|
| Instruction | 2 L Hours per Week |
| Duration of Semester End Examination | 2 Hours |
| Semester End Examination | 50 Marks |
| Continuous Internal Evaluation | - |
| Credits | Non Credit |

**PREREQUISITE**: Writing to express on science and technological concepts with good taste for research and development.

**COURSE OBJECTIVES:** This course aims to

1. Motivate learners for academic writing and thus encourage them for continuous professional updating and up-gradation.
2. Facilitate a practical understanding of the multiple purposes of Writing Research Papers and help them infer the benefits and limitations of research in science and technology.
3. Brainstorm and develop the content, formulating a structure and illustrating the format of writing a research paper.
4. Survey and select a theme/topic for a thorough reading and to writing a research paper.
5. Understand to implement the intricacies of writing and publishing a research paper.

**COURSE OUTCOMES:** After the completion of this course, the student will be able to

1. Improve work performance and efficiency. Illustrate the nuances of research paper writing and draw conclusions on professional usefulness.
2. Classify different types of research papers and organize the format and citation of sources.
3. Explore various formats of APA, MLA and IEEE and set up for writing a research paper.
4. Draft paragraphs and write theme based thesis statements in a scientific manner.
5. Develop an original research paper while acquiring the knowledge of how and where to publish their papers.

**CO-PO Articulation Matrix**

| PO / CO | PO 1 | PO 2 | PO 3 | PO 4 |
|---|---|---|---|---|
| **CO 1** | 1 | 2 | 1 | 1 |
| **CO 2** | 1 | 1 | 1 | 1 |
| **CO 3** | 1 | 2 | 2 | 1 |
| **CO 4** | 1 | 2 | 1 | 1 |
| **CO 5** | 2 | 3 | 1 | 1 |

1-Slightly, 2-Moderately, 3-Substantially

**UNIT-I**

**Academic Writing:** Meaning and Definition of a research paper, Purpose of a research paper, Scope, Benefits, Limitations and outcomes for professional development, an introduction to methods and Approaches of Research.

**UNIT-II**

**Research Paper Format:** Title, Abstract, Introduction, Discussion, Findings, Conclusion, Style of Indentation, Font size / Font types, Indexing, Citation of sources.

**UNIT-III**

**Process of Writing** a research paper, writing to Draft a Format, Develop content, Adapting, Reviewing, Paraphrasing and Plagiarism Checks.

**UNIT-IV**

**Choosing a topic:** Thesis Statement, Outline, Organizing notes, Language of Research, Word order, Paragraphs, Writing first draft, Revising / Editing, The final draft and proof reading. Understanding APA, MLA, IEEE formats.

**UNIT-V**

**Research Paper Publication** Reputed Journals, Paid, Free and peer reviewed journals, National / International - ISSN No, No. of volumes, Scopus Index/UGC Journals. Getting Papers Published.

## TEXT BOOKS:


1. Kothari, C. R. and Gaurav, Garg, Research Methodology Methods and Techniques", 4thEdition, New Age International Publishers, New Delhi, 2019.
2. Ellison, Carroll. "Writing Research Papers", McGraw Hill's Concise Guide, 2010.
3. Lipson, Charles. "Cite Right: A Quick Guide to Citation Styles-- MLA, APA, Chicago, the Sciences, Professions, and More", 2nd Edition, University of Chicago Press. Chicago, 2018.


## SUGGESTED READING:


1. Day, Robert A. "How to Write and Publish a Scientific Paper", Cambridge University Press, 2006.
2. Girden, E. R. "MLA Hand book for writers of Research Papers", 7th Edition, East West Press Pvt. Ltd, New Delhi, 2009.
3. Bailey, Stephen. "Academic Writing: A Handbook for International Students", Routledge, 2018.


## ONLINE RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc 18_mg13/preview
2. https://nptel.ac.in/courses/121/106/121106007/
3. https://www.classcentral.com/course/swayam-introduction-to-research-5221

## WRITING TOOLS:

1. https://owl.purdue.edu/owl_exercises/index.html - The Owl writing lab
2. https://www.turnitin.com/login_page.asp?lang=en_us – Turn tin software

**26CEA101**

## DISASTER MITIGATION AND MANAGEMENT

**(Audit Course I and II - Common to all branches)**

| | |
|---|---|
| Instruction | 2 L Hours per Week |
| Duration of Semester End Examination | 2 Hours |
| Semester End Examination | 50 Marks |
| Continuous Internal Evaluation | - |
| Credits | Non Credit |

**COURSE OBJECTIVES:** This course aims to

1. Equip the students with the basic knowledge of hazards, disasters, risks and vulnerabilities, including natural, climatic and human-induced factors and associated impacts.
2. Impart knowledge in students about the nature, causes, consequences and mitigation measures of the various natural disasters.
3. Enable the students to understand risks, vulnerabilities and human errors associated with human-induced disasters.
4. Enable the students to understand and assimilate the impacts of any disaster on the affected area, depending on its position/ location, environmental conditions, demographic, etc.
5. Equip the students with the knowledge of the chronological phases in a disaster management cycle and to create awareness about the disaster management framework and legislations in the context of national and global conventions

**COURSE OUTCOMES:** After the completion of this course, the student will be able to

1. Ability to analyse and critically examine existing programs in disaster management regarding vulnerability, risk and capacity at different levels.
2. Ability to understand and choose the appropriate activities and tools, and set up priorities to build a coherent and adapted disaster management plan.
3. Ability to understand various mechanisms and consequences of human-induced disasters for the participatory role of engineers in disaster management.
4. To understand the impact on various elements affected by the disaster and to suggest and apply appropriate measures for the same.
5. Develop an awareness of the chronological phases of disaster preparedness, response and relief operations for formulating effective disaster management plans and the ability to understand various participatory approaches/strategies and their application in disaster management.

**CO-PO Articulation Matrix**

| PO / CO | PO 1 | PO 2 | PO 3 | PO 4 |
|---|---|---|---|---|
| **CO 1** | 2 | 3 | 2 | 1 |
| **CO 2** | 3 | 3 | 2 | 2 |
| **CO 3** | 2 | 3 | 3 | 2 |
| **CO 4** | 3 | 3 | 2 | 3 |
| **CO 5** | 3 | 2 | 2 | 3 |

1-Slightly, 2-Moderately, 3-Substantially

**UNIT- I**

**Introduction:** Basic definitions- Hazard, Disaster, Vulnerability, Risk, Resilience, Mitigation, Management; classification of types of disaster-Natural and manmade; International Decade for natural disaster reduction (IDNDR); International strategy for disaster reduction (ISDR), National disaster management authority (NDMA).

**UNIT- II**

**Natural Disasters**: Hydro meteorological disasters: Causes, Early warning systems- monitoring and management, structural and non-structural measures for floods, drought and Tropical cyclones; Geographical based disasters: Tsunami generation, causes, zoning, Early warning systems- monitoring and management, structural and non-structural mitigation measures for earthquakes, tsunami, landslides, avalanches and forest fires. Case studies related to various hydro-meteorological and geographical based disasters.

**UNIT- III**

**Human induced hazards:** Chemical disaster- Causes, impacts and mitigation measures for chemical accidents, Risks and control measures in a chemical industry, chemical disaster management; Case studies related to various chemical industrial hazards eg.: Bhopal gas tragedy; Management of chemical terrorism disasters and biological disasters; Radiological Emergencies and case studies; Case studies related to major power break downs, fire accidents, traffic accidents, oil spills and stampedes, disasters due to double cellar construction in multistoried buildings.

**UNIT- IV**

**Disaster Impacts:** Disaster impacts- environmental, physical, social, ecological, economic, political, etc.; health, psycho-social issues; demographic aspects- gender, age, special needs; hazard locations; global and national disaster trends; climate change and urban disasters.

**UNIT- V**

**Concept of Disaster** Policies and legislation for disaster risk reduction

**Management:** Disaster management cycle – its phases; prevention, mitigation, preparedness, relief and recovery; risk analysis, vulnerability and capacity assessment; post-disaster environmental response water, sanitation, food safety, waste management, disease control; Roles and responsibilities of government, community, local in situations, NGOs and other stakeholders;, DRR programmers in India and the activities of National Disaster Management Authority.

## TEXT BOOKS:


1. Pradeep Sahni," Disaster Risk Reduction in South Asia", 1st Edition, Prentice Hall, 2003.
2. B. K. Singh," Handbook of Disaster Management: techniques &Guidelines", 1st Edition, Rajat Publication, 2008.
3. Ministry of Home Affairs". Government of India, "National disaster management plan, Part I and II",
4. K. K.Ghosh, Disaster Management", 1st Edition, APH Publishing Corporation, 2006.


## SUGGESTED READING:


1. http://www.indiaenvironmentportal.org.in/files/file/disaster_management_india1.pdf
2. http://www.ndmindia.nic.in/ (National Disaster management in India, Ministry of Home Affairs)
3. Hazards, Disasters and your community: A booklet for students and the community, Ministry of home affairs.

**26EEA101**

## SANSKRIT FOR COMPUTATIONAL THINKING AND ENGINEERING APPLICATIONS

**(Audit Course I and II - Common to all branches)**

| | |
|---|---|
| Instruction | 2 L Hours per Week |
| Duration of Semester End Examination | 2 Hours |
| Semester End Examination | 50 Marks |
| Continuous Internal Evaluation | - |
| Credits | Non Credit |

**COURSE OBJECTIVES:** This course aims to

1. Introduce Sanskrit as a structured language useful for logical thinking and algorithm design.
2. Connect Sanskrit concepts with modern engineering domains (AI, circuits, structures, systems).
3. Develop computational and analytical skills using Sanskrit-based principles.
4. Enable students to explore interdisciplinary applications for research and innovation.

**COURSE OUTCOMES:** After the completion of this course, the student will be able to

1. Apply structured Sanskrit rules to improve logical and algorithmic thinking.
2. Relate concepts from Sanskrit texts to modern Engineering principles.
3. Develop simple computational models inspired by Sanskrit grammar/logics.
4. Use Sanskrit-based frameworks in AI, coding logic, or system design.
5. Identify interdisciplinary research opportunities combining Sanskrit & Engineering.

**CO-PO Articulation Matrix**

| PO / CO | PO 1 | PO 2 | PO 3 | PO 4 |
|---|---|---|---|---|
| **CO 1** | 2 | 1 | 2 | 1 |
| **CO 2** | 2 | 1 | 2 | 2 |
| **CO 3** | 3 | 1 | 3 | 3 |
| **CO 4** | 3 | 2 | 3 | 3 |
| **CO 5** | 3 | 2 | 2 | 3 |

1-Slightly, 2-Moderately, 3-Substantially

**UNIT-I**

**Sanskrit as a Structured Language :** Sanskrit as rule-based system -Basics: alphabets, word formation (only essentials) -Sandhi as **data compression analogy** -Samasa as **modular design / block abstraction**-Simple sentence formation (very minimal grammar).

**UNIT-II**

**Sanskrit and Computational Thinking:** Paninian grammar → rule engine / compiler design -Shiva Sutras → encoding system-.

Binary concepts in Pingala (Chandas → digital logic) -Recursion & patterns in Sanskrit structures

**UNIT-III**

**Sanskrit in Core Engineering Domains**

**Civil / Mechanical:**

Sulba Sutras → geometry, measurements -Ancient construction logic → modular design .

**Electrical / ECE:**

Concept of energy (Agni, Surya) → symbolic + physical mapping -Wave & sound (Nada → signal analogy) .

**Systems Thinking:** Interconnectedness → system design philosophy.

**UNIT-IV**

**Sanskrit and Modern Technology:** Sanskrit and Artificial Intelligence (knowledge representation) -Natural Language Processing (NLP) -Formal languages and syntax -Command-based structures → programming analogy.

**UNIT-V**

**Mini Applications and Case Studies:** Case study: Sanskrit → Algorithm (simple flowchart) -Chandas → binary pattern generation-Design a simple rule-based system using Sanskrit logic -Mini presentation / activity

## TEXT BOOKS:


1. Kapil Kapoor – "Language, Linguistics and Literature- Indian Perspective", 1st Edition, Academic Foundation, 1994; ISBN: 978-8171880577.
2. Frits Staal, "A Reader on the Sanskrit Grammarians", MIT Press / Motilal Banarsidass ; 1972 ISBN: 978-0262191340.
3. George Gheverghese Joseph, "The Crest of the Peacock", 2nd Edition, Princeton University Press; 2000, ISBN: 978-0691135267.
4. B.V. Subbarayappa: "Indian Scientific Heritage", National Institute of Advanced Studies (NIAS), Bangalore, 2006, ISBN: 978-8185015026.
5. M. Krishnamachariar, "History of Sanskrit Literature", Motilal Banarsidass Publishers; Reprint 1993, ISBN: 978-8120802841.


## SUGGESTED READING:


1. Pingala. Chandah Shastra (various editions, Nirnaya Sagar Press / Chowkhamba).
2. Bharati, A., et al. Natural Language Processing: A Paninian Perspective, PHI, 1995.
3. Selected IEEE / Springer Papers on Sanskrit & AI.

**26ECA101**

## VALUE EDUCATION

**(Audit Course I and II - Common to all branches)**

| | |
|---|---|
| Instruction | 2 L Hours per Week |
| Duration of Semester End Examination | 2 Hours |
| Semester End Examination | 50 Marks |
| Continuous Internal Evaluation | - |
| Credits | Non Credit |

**PREREQUISITE:**

**COURSE OBJECTIVES:** This course aims to

1. Understand Value Education, Self-development and National development.
2. Imbibe good human values and Morals in students.
3. Cultivate individual and National character.

**COURSE OUTCOMES:** After the completion of this course, the student will be able to

1. Summarize classification of values and values for self-development.
2. Identify the importance of values in personal and professional life.
3. Apply the importance of social values for better career and relationships.
4. Analyze ethical issues in modern technology.
5. Discuss concept of soul and reincarnation and promote responsible citizenship

**CO-PO Articulation Matrix**

| PO / CO | PO 1 | PO 2 | PO 3 | PO 4 |
|---|---|---|---|---|
| **CO 1** | 2 | 2 | 2 | 2 |
| **CO 2** | 2 | 2 | 2 | 2 |
| **CO 3** | 2 | 2 | 2 | 3 |
| **CO 4** | 3 | 2 | 2 | 3 |
| **CO 5** | 2 | 2 | 3 | 3 |

1-Slightly, 2-Moderately, 3-Substantially

**UNIT - I**

**Human Values, Ethics and Morals:** Concept of Values, Human Values, Indian concept of humanism, Values for self-development, Social values, Individual attitudes, Work ethics, Moral and non- moral behavior, Standards and Principles based on religion, Culture and Tradition.

**UNIT - II**

**Value Cultivation, and Self-Management:** Need and Importance of cultivation of values such as Sense-of Duty, Devotion to work, Self-reliance, Confidence, Concentration, Integrity & discipline, and Truthfulness.

**UNIT - III**

**Spiritual Outlook and Social Values:** Personality and Behaviour Development, Scientific attitude and Spiritual (soul) outlook, Cultivation of Social Values Such as Positive Thinking, Punctuality, Love & Kindness, Avoiding fault finding in others, Reduction of anger, Forgiveness, Dignity of labour, True friendship, Universal brotherhood and religious tolerance., Happiness Vs Suffering, Love for truth, Aware of self-destructive habits, Appreciation and co-operation.

**UNIT - IV**

**Technology, Society, and Sustainability:** Ethics in emerging technologies (AI, Data, 5G, IoT); Privacy and cybersecurity, Environmental ethics and sustainable development; Social responsibility of engineers, Policy and governance.

**UNIT - V**

**Universal Values and Global Perspectives:** Mind your mind, Self-control**,** Concept of soul, Science of Reincarnation, Concepts of Dharma and Karma, The qualities of Devine and Devilish, Satwic, Rajasic and Tamasicgunas. Global citizenship, Happiness and meaningful life.

## TEXT BOOKS:


1. Chakroborty, S.K. "Values & Ethics for organizations Theory and practice", Oxford University Press, New Delhi, 1998.
2. Jaya Dayal Goyandaka, "Srimad Bhagavad Gita", with Sanskrit Text, Word meaning and Prose meaning, Gita Press, Gorakhpur, 2017.


## SUGGESTED READING:


1. George Reynolds, Ethics in Information Technology, 6th Edition, Cengage Learning, 2018
2. Melanie Mitchell, Artificial Intelligence: A Guide for Thinking Humans, 1st Edition, Farrar, Straus and Giroux, 2019

**26EGA102**

## CONSTITUTION OF INDIA

**(Audit Course I and II - Common to all branches)**

| | |
|---|---|
| Instruction | 2 L Hours per Week |
| Duration of Semester End Examination | 2 Hours |
| Semester End Examination | 50 Marks |
| Continuous Internal Evaluation | - |
| Credits | Non Credit |

**PREREQUISITE**: Knowledge on basics of the Constitution and the Government.

**COURSE OBJECTIVES:** This course aims to

1. The history of Indian Constitution and its role in the Indian democracy.
2. Address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
3. Have knowledge of the various Organs of Governance and Local Administration.

**COURSE OUTCOMES:** After the completion of this course, the student will be able to

1. Understand the making of the Indian Constitution and its features.
2. Understand the Rights of equality, the Right of freedom and the Right to constitutional remedies.
3. Have an insight into various Organs of Governance - composition and functions.
4. Understand powers and functions of Municipalities, Panchayats and Co-operative Societies.
5. Understand Electoral Process, special provisions.

**CO-PO Articulation Matrix**

| PO / CO | PO 1 | PO 2 | PO 3 | PO 4 |
|---|---|---|---|---|
| **CO 1** | 1 | 1 | 1 | 1 |
| **CO 2** | 1 | 1 | 1 | 1 |
| **CO 3** | 1 | 1 | - | 1 |
| **CO 4** | - | - | - | - |
| **CO 5** | - | - | - | - |

1-Slightly, 2-Moderately, 3-Substantially

**UNIT-I**

**History of making of the Indian constitutions:** History, Drafting Committee (Composition & Working).

**Philosophy of the Indian Constitution**: Preamble, Salient Features.

**UNIT-II**

**Contours of Constitutional Rights and Duties:** Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

**UNIT-III**

**Organs of Governance:** Parliament: Composition, Qualifications, Powers and Functions.

**Union executives :** President, Governor, Council of Ministers, Judiciary, appointment and transfer of judges, qualifications, powers and functions.

**UNIT-IV**

**Local Administration:** District's Administration head: Role and importance. Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation.

**Panchayati Raj:** Introduction, PRI: Zilla Panchayat, Elected Officials and their roles, CEO Zilla Panchayat: positions and role.
**Block level:** Organizational Hierarchy (Different departments) Village level: role of elected and appointed officials. Importance of grass root democracy.

**UNIT-V**
**Election commission:** Election Commission: Role and functioning, Chief Election Commissioner and Election Commissioners, State Election Commission: Role and functioning. Institute and Bodies for the welfare of SC/ST/OBC and women**.**

## TEXT BOOKS:


1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Busi, S. N., Dr. B. R. Ambedkar, Framing of Indian Constitution'', 1st Edition, Ava Publishers, New Delhi, 2015.
3. Jain, M. P., "Indian Constitution Law", 7th Edition, Lexis Nexis, New Delhi, 2014.
4. Basu, D.D. "Introduction to the Constitution of India", Lexis Nexis, New Delhi. 2015.


## SUGGESTED READING:


1. Bhargava, Rajeev. (ed), "Politics and Ethics of the Indian Constitution", OUP, 2008.
2. NCERT, Indian Constitution at Work, 1st Edition, Government of India, New Delhi 2006, reprinted in 2022.
3. Ravindra Sastry, V. (ed.), Indian Government & Politics, 2nd Edition, Telugu Academy, 2018.


## ONLINE RESOURCES:

1. http://www.nptel.ac.in/courses/103107084/Script.pdf

**26ADA101**

## PEDAGOGY STUDIES

**(Audit Course I and II - Common to all branches)**

| | |
|---|---|
| Instruction | 2 L Hours per Week |
| Duration of Semester End Examination | 2 Hours |
| Semester End Examination | 50 Marks |
| Continuous Internal Evaluation | - |
| Credits | Non Credit |

**COURSE OBJECTIVES:** This course aims to

1. Present the basic concepts of design and policies of pedagogy studies.
2. Provide understanding of the abilities and dispositions with regard to teaching techniques, curriculum design and assessment practices.
3. Familiarize various theories of learning and their connection to teaching practice.
4. Create awareness about the practices followed by DFID, other agencies and other researchers.
5. Provide understanding of critical evidence gaps that guides the professional development.

**COURSE OUTCOMES:** After the completion of this course, the student will be able to

1. Illustrate the pedagogical practices followed by teachers in developing countries both in formal and informal classrooms.
2. Examine the effectiveness of pedagogical practices.
3. Understand the concept, characteristics and types of educational research and perspectives of research.
4. Describe the role of classroom practices, curriculum and barriers to learning.
5. Understand Research gaps and learn the future directions.

**CO-PO Articulation Matrix**

| PO / CO | PO 1 | PO 2 | PO 3 | PO 4 |
|---|---|---|---|---|
| **CO 1** | 1 | 1 | 1 | - |
| **CO 2** | 1 | 1 | 1 | - |
| **CO 3** | 2 | 2 | 2 | - |
| **CO 4** | 1 | 1 | 1 | - |
| **CO 5** | 2 | 2 | 2 | - |

1-Slightly, 2-Moderately, 3-Substantially

**UNIT-I**

**Introduction and Methodology:** Aims and rationale, Policy background, Conceptual framework and terminology, Theories of learning, Curriculum, Teacher education, Conceptual framework, Research questions, Overview of methodology and Searching.

**UNIT-II**

**Thematic Overview:** Pedagogical practices followed by teachers in formal and informal classrooms in developing countries, Curriculum, Teacher education.

**UNIT-III**

**Evidence on the Effectiveness of Pedagogical Practices:** Methodology for the in depth stage: quality assessment of included studies, How can teacher education (curriculum and Practicum) and the school curriculum and guidance material best support effective pedagogy's, Theory of change, Strength and nature of the body of evidence for effective pedagogical practices, Pedagogic theory and pedagogical approaches, Teachers' attitudes and beliefs and pedagogic strategies.

**UNIT-IV**

**Professional Development:** alignment with classroom practices and follow up support, Support from the head teacher and the community, Curriculum and assessment, Barriers to learning: Limited resources and large class sizes.

**UNIT-V**

**Research Gaps and Future Directions:** Research design, Contexts, Pedagogy, Teacher education, Curriculum and assessment, Dissemination and research impact.

## TEXT BOOKS:


1. Ackers J, Hardman F, "Classroom Interaction in Kenyan Primary Schools, Compare", 31 (2): 245 – 261, 2001.
2. Agarwal M, "Curricular Reform in Schools: The importance of evaluation", Journal of Curriculum Studies, 36 (3): 361 – 379, 2004.

**26EGA103**

## STRESS MANAGEMENT BY YOGA

**(Audit Course I and II - Common to all branches)**

| | |
|---|---|
| Instruction | 2 L Hours per Week |
| Duration of Semester End Examination | 2 Hours |
| Semester End Examination | 50 Marks |
| Continuous Internal Evaluation | - |
| Credits | Non Credit |

**PREREQUISITE**: Knowledge on Yoga Practices.

**COURSE OBJECTIVES:** This course aims to

1. Create awareness about different types of stress and the role of yoga in the management of stress.
2. Promote positive health and overall well-being (Physical, mental, emotional, social and spiritual).
3. Prevent stress related health problems by yoga practice.

**COURSE OUTCOMES:** After the completion of this course, the student will be able to

1. Understand yoga and its benefits.
2. Enhance Physical strength and flexibility.
3. Learn to relax and focus.
4. Relieve physical and mental tension through asanas.
5. Improve work performance and efficiency.

**CO-PO Articulation Matrix**

| PO / CO | PO 1 | PO 2 | PO 3 | PO 4 |
|---|---|---|---|---|
| **CO 1** | - | - | - | - |
| **CO 2** | - | - | - | - |
| **CO 3** | 1 | - | - | 1 |
| **CO 4** | - | - | - | - |
| **CO 5** | 1 | 1 | 1 | 1 |

1-Slightly, 2-Moderately, 3-Substantially

**UNIT-I**

**Meaning and definition of Yoga:** Historical perspective of Yoga, Principles of Astanga Yoga by Patanjali).

**UNIT-II**

**Meaning and definition of Stress:** Types of stress, Eustress and Distress. Anticipatory Anxiety and Intense Anxiety and depression. Meaning of Management, Stress Management.

**UNIT-III**

**Concept of Stress according to Yoga:** Stress assessment methods, Role of Asana, Pranayama and Meditation in the management of stress.

**UNIT-IV**

**Asanas**- (5 Asanas in each posture), Warm up, Standing Asanas, Sitting Asanas, Prone Asanas, Supine asanas, Surya Namaskar.

**UNIT–V**

**Pranayama:** Anulom and Vilom Pranayama, Nadishudhi Pranayama, Kapalabhati Pranayama, Bhramari Pranayama, Nadanusandhana Pranayama.

**Meditation techniques:** Om Meditation, Cyclic meditation, Instant Relaxation technique (IRT), Quick Relaxation Technique (QRT), Deep Relaxation Technique (DRT)

## TEXT BOOKS:


1. Janardhan, Swami, "Yogic Asanas for Group Training - Part-I": Yogabhyasi Mandal, Nagpur.
2. Vivikananda, Swami**.** "Rajayoga or Conquering the Internal Nature", Advaita Ashrama (Publication Department), Kolkata.
3. Nagendra H.R and R. Nagaratna, "Yoga Perspective in Stress Management", Swami Vivekananda Yoga Prakashan, Bangalore.


## ONLINE RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc16_ge04/preview
2. https://freevideolectures.com/course/3539/indian-philosophy/11

**26EGA104**

## PERSONALITY DEVELOPMENT THROUGH LIFE'S ENLIGHTENMENT SKILLS

**(Audit Course I and II - Common to all branches)**

| | |
|---|---|
| Instruction | 2 L Hours per Week |
| Duration of Semester End Examination | 2 Hours |
| Semester End Examination | 50 Marks |
| Continuous Internal Evaluation | - |
| Credits | Non Credit |

**PREREQUISITE**: Awareness on Personality Development.

**COURSE OBJECTIVES:** This course aims to

1. Learn to achieve the highest goal happily.
2. Become a person with stable mind, pleasing personality and determination.
3. Awake wisdom among themselves.

**COURSE OUTCOMES:** After the completion of this course, the student will be able to

1. Develop their personality and achieve their highest goal of life.
2. Lead the nation and mankind to peace and prosperity.
3. Practice emotional self-regulation.
4. Develop a positive approach to work and duties.
5. Develop a versatile personality

**CO-PO Articulation Matrix**

| PO / CO | PO 1 | PO 2 | PO 3 | PO 4 |
|---|---|---|---|---|
| **CO 1** | 1 | 1 | 1 | 1 |
| **CO 2** | 1 | - | - | 1 |
| **CO 3** | 1 | 1 | - | 1 |
| **CO 4** | 1 | - | - | 1 |
| **CO 5** | 1 | 1 | - | 1 |

1-Slightly, 2-Moderately, 3-Substantially

**UNIT-I**

**Neetisatakam – Holistic development of personality:** Verses 19, 20, 21, 22 (Wisdom), Verses 29, 31, 32 (Pride and Heroism), Verses 26,28,63,65 (Virtue).

**UNIT-II**

**Neetisatakam – Holistic development of personality (cont'd)**: Verses 52, 53, 59 (dont's), Verses 71, 73, 75& 78 (do's) - Approach to day to day works and duties.

**UNIT-III**

**Introduction to Bhagavadgeetha for Personality Development: Shrimad Bhagawad Geeta**: Chapter 2-Verses 41, 47, 48, Chapter 3-Verses 13,21,27,35, Chapter 6-Verses 5,13,17,23,35, Chapter 18-Verses 45, 46, 48, Chapter-6-Verses 5, 13, 17, 23, 35, Chapter 8-Verses 45, 46, 48.

**UNIT-IV**

**Statements of basic knowledge – Shrimad Bhagawad Geeta**: Chapter 2-Verses 56, 62, 68, Chapter 12-Verses 13, 14, 15, 16, 17, 18, Personality of Role model from Shrimad Bhagawat Geeta.

**UNIT-V**

**Role of Bahgavadgeeta in the present scenario:** Chapter 2-Verses 17, Chapter 3-Verses 36, 37, 42, Chapter 4-Verses 18, 38, 39, Chapter 18-Verses 37, 38, 63.

**TEXT BOOKS:**

1. Gopinath, P., "Bhartrihari's Three Satakam (Niti-sringar-vairagya)", Rashtriya Sanskrit Sansthanam, New Delhi, 2018.
2. Swarupananda, Swami, "Srimad Bhagavad Geeta", Advaita Ashram (Publication Dept), Kolkata, 2017.

**ONLINE RESOURCES:**

1. http://nptel.ac.in/downloads/109104115/

**26CSC103**

## ADVANCED ALGORITHMS LAB

| | |
|---|---|
| Instruction | 2 P Hours per Week |
| Duration of Semester End Examination | - |
| Semester End Examination | - |
| Continuous Internal Evaluation | 50 Marks |
| Credits | 1 |

**PREREQUISITES:** UG level course in Design and analysis of algorithm Lab using any programming Language.

**COURSE OBJECTIVES:** This course aims to

1. Built up strong skills to implement algorithms for various problems.
2. Familiarize with efficient utilization of programming language constructs while implementing algorithms along with their complexities.
3. Able to apply strategies to solve realtime problems.

**COURSE OUTCOMES:** After completion of this course, students will be able to

1. Identify and implement appropriate data structures and sorting/graph algorithms, including randomized data structures, to solve computational problems.
2. Analyze and compare the time complexity of deterministic and randomized algorithm implementations through empirical measurement and theoretical verification.
3. Implement greedy, divide-and-conquer, dynamic programming, and randomized algorithmic paradigms for graph, flow, and optimization problems.
4. Evaluate computational efficiency by applying multiple algorithmic paradigms to the same problem instance and measuring performance trade-offs.
5. Design, implement, test, and present complete algorithmic solutions — incorporating randomized techniques where appropriate — for real-world computational problems.

**CO-PO Articulation Matrix**

| PO / CO | PO 1 | PO 2 | PO 3 | PO 4 |
|---|---|---|---|---|
| **CO 1** | 3 | 3 | 2 | 3 |
| **CO 2** | 3 | 2 | 3 | 3 |
| **CO 3** | 3 | 2 | 3 | 3 |
| **CO 4** | 3 | 2 | 2 | 3 |
| **CO 5** | 3 | 2 | 3 | 3 |

1-Slightly, 2-Moderately, 3-Substantially

## LIST OF EXPERIMENTS:

1. Implementation of Stack, Queue, and Linked List with time/space analysis and amortized analysis using dynamic array doubling strategy.
2. Implementation of Sorting — Heap Sort, Quick Sort, and Topological Sort using queue, BFS using queue and DFS using a stack: storing adjacency list using linked list.
3. Implementation of Randomized QuickSort and compare expected vs worst-case runtime against deterministic QuickSort for n = 1000, 5000, 10000. Simulate the Hiring Problem.
4. Implementation of Universal Hashing and compare collision rates vs fixed hash function.
5. Implement Skip List with probabilistic balancing and Interval Index.
6. Implementation of Minimum Spanning Trees using Kruskal's algorithm (matroid-based greedy) and Prim's algorithm.
7. Implementation of Maximum Matching using augmenting paths and Edmonds' Blossom algorithm for general graphs.

8. Implementation of Ford-Fulkerson and Edmonds-Karp algorithms for maximum flow and compare the number of augmentations on different capacity networks.
9. Implementation of Strassen's Matrix Multiplication and LUP-decomposition. Compare Strassen vs naive matrix multiplication for n = 64, 128, 256, 512.
10. Implementation of Floyd-Warshall, 0/1 Knapsack, Longest Common Subsequence, Matrix Chain Multiplication, and Optimal Binary Search Tree.

## TEXT BOOKS:


1. Mark Allen Weiss, "Data Structures and Algorithm Analysis in C++", 2nd Edition, Pearson, 2004.
2. Sanjoy Dasgupta, Christos Papadimitriou, Umesh Vazirani, "Algorithms", 1st Edition, McGraw-Hill, 2006


## SUGGESTED READING:


1. Alfred V. Aho, John E. Hopcroft, Jeffrey D. Ullman, "The Design and Analysis of Computer Algorithms", 1st Edition, Pearson Addison-Wesley Publication, Originally published on 1974.
2. Jon Kleinberg, Eva Tardos, "Algorithm Design", 1st Edition, Pearson Addison-Wesley Publication, 2009.
3. Motwani, Raghavan "Randomized Algorithms", 1st Edition, Cambridge Univ. Press 1995


## ONLINE RESOURCES:

1. http://www.nptelvideos.in/2012/11/data-structures-and-algorithms. Html
2. https://www.geeksforgeeks.org/top-algorithms-and-data-structures-for-competitive-programming/
3. http://www. nptelvideos. com/java/java _ video _ Lecture Hours_tutorials.php

**26CSE111**

## DEEP LEARNING LAB
**(Professional Elective-II Lab)**

| | |
|---|---|
| Instruction | 3 P Hours per Week |
| Duration of Semester End Examination | - |
| Semester End Examination | - |
| Continuous Internal Evaluation | 50 Marks |
| Credits | 1.5 |

**PREREQUISITE:** UG level Course in Artificial Intelligence and Machine Learning.

**COURSE OBJECTIVES:** This course aims to
1. Understand basic concepts of Deep learning and their applications.
2. Evaluating Deep learning methods, models and algorithms.
3. Analyzing CNN, RNN, Transformers and GAN along with their applications

**COURSE OUTCOMES:** After completion of this course, students will be able to
1. Evaluate the performance of various optimization techniques used in deep learning.
2. Analyze various Autoencoders and Regularization Techniques.
3. Design and develop various Convolution Neural Networks architectures.
4. Analyze various RNNs and Encoder Decoder Models.
5. Understand the importance of Transformers and GANs to develop real-time applications.

**CO-PO Articulation Matrix**

| PO / CO | PO 1 | PO 2 | PO 3 | PO 4 |
|---|---|---|---|---|
| **CO 1** | 3 | 3 | 3 | 2 |
| **CO 2** | 3 | 3 | 3 | 2 |
| **CO 3** | 3 | 2 | - | 2 |
| **CO 4** | 3 | 2 | 3 | 2 |
| **CO 5** | 2 | 1 | - | - |

1-Slightly, 2-Moderately, 3-Substantially

**LIST OF EXPERIMENTS:**
1. Implementation of Classification with Multilayer Perceptron using Scikit-learn with MNIST Dataset.
2. Understanding the Deep Learning Packages Basics: Tensorflow, Keras, Theano and PyTorch.
3. Compare the Performance of various Optimization techniques of Momentum Based GD, Stochastic GD, Adam.
4. Implementation of Autoencoders to compress high-dimensional data.
5. Compare the Performance of the Classification model using various Regularization Techniques.
6. Train a Deep Learning model to classify a given image using pretrained models and compare their performance.
7. Implementation of Time Series forecasting using LSTM.
8. Implementation of Encoder Decoder Models.
9. Understand the working of Vision Transformers.
10. Implementation of GANs for generating synthetic datasets.

**TEXT BOOKS:**
1. Giancarlo Zaccone, Md. RezaulKarim, Ahmed Menshawy "Deep Learning with TensorFlow: Explore neural networks with Python", 2nd Edition, Packt Publisher, 2017.

2. Rothman, Denis. "Transformers for natural language processing and computer vision: explore generative AI and large language models with Hugging Face, ChatGPT, GPT-4V, and DALL-E 3." 3rd Edition, Packt Publishing, 2024.

## SUGGESTED READING:

1. Ian Goodfellow. I., Bengio. Y. and Courville. A., "Deep Learning ", 1st Edition, MIT Press, 2016.
2. Kuntal Ganguly, "Learning Generative Adversarial Networks: Next-generation deep learning simplified", 1st Edition, Packt Publisher, 2017.
3. Benjamin Planche, Eliot Andres, "Hands-On Computer Vision with TensorFlow 2: Leverage deep learning to create powerful image processing apps with TensorFlow", 1st Edition, Packt Publishers, 2019.

## ONLINE RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc18_cs41/
2. https://onlinecourses.nptel.ac.in/noc22_cs22/
3. https://onlinecourses.nptel.ac.in/noc19_cs85/

**26CSE112**

## CONCURRENT PROGRAMMING LAB
**(Professional Elective-II Lab)**

| | |
|---|---|
| Instruction | 3 P Hours per Week |
| Duration of Semester End Examination | - |
| Semester End Examination | - |
| Continuous Internal Evaluation | 50 Marks |
| Credits | 1.5 |

**PREREQUISITES:** Operating Systems, Basics of Object-Oriented Programming.

**COURSE OBJECTIVES:** This course aims to
1. Develop the ability to apply multithreading and synchronization techniques to solve classical concurrency problems.
2. Provide knowledge of concurrency control mechanisms and memory models
3. Enable the design and implementation of efficient concurrent algorithms and data structures.

**COURSE OUTCOMES:** After the completion of this course, the student will be able to
1. Apply multithreading and synchronization techniques.
2. Implement, and analyze mutual exclusion algorithms
3. Analyze and evaluate consistency models and Java memory constructs.
4. Design and implement synchronization primitives and non-blocking synchronization techniques.
5. Evaluate concurrent data structures.

**CO-PO Articulation Matrix**

| PO / CO | PO 1 | PO 2 | PO 3 | PO 4 |
|---|---|---|---|---|
| **CO 1** | 3 | 1 | 2 | 3 |
| **CO 2** | 3 | 1 | 2 | 3 |
| **CO 3** | 3 | 2 | 2 | 3 |
| **CO 4** | 3 | 1 | 2 | 3 |
| **CO 5** | 3 | 2 | 2 | 3 |

1-Slightly, 2-Moderately, 3-Substantially

**LIST OF EXPERIMENTS:**
1. Implement the Producer–Consumer problem using multithreading and synchronization primitives such as semaphores or monitors.
2. Design and implement a solution to the Critical Section problem using mutex locks for process synchronization.
3. Implement software-based mutual exclusion using Peterson's Algorithm for two concurrent processes/threads.
4. Implement N-process mutual exclusion using Lamport's Bakery Algorithm and analyze fairness and correctness.
5. Implement Java synchronization mechanisms using synchronized methods, blocks, and monitors for thread-safe execution.
6. Demonstrate the role of volatile and final fields in Java concurrency and analyze their impact on memory visibility and consistency.
7. Design and implement a spinlock using atomic variables based on the Test-And-Set (TAS) operation.
8. Implement a lock-free counter using Compare-And-Set (CAS) operations and evaluate its performance under concurrency.
9. Design and implement a concurrent linked list using fine-grained locking to improve parallelism and scalability.

10. Implement concurrent stack and queue data structures using both blocking synchronization and lock-free approaches, and compare their performance.

**TEXT BOOKS:**


3. Maurice Herlihy, Nir Shavit, Victor Luchangco, Michael Spear, "The Art of Multiprocessor Programming", Paperback 2nd Edition, Morgan Kaufmann,2020.
4. Michal Raynal, "Concurrent Programming: Algorithms, Principles, and Foundations", 1st Edition, Springer Berlin, Heidelberg. 2015.


**SUGGESTED READING:**


1. Michel Charpentier, "Functional and Concurrent Programming: Core Concepts and Features", 1st Edition Addison-Wesley, 2022.
2. Maurice Herlihy and Nir Shavit, "The Art of Multiprocessor Programming", 1st Edition, Morgan Kaufmman Publishers, 2012.
3. Brian Goetz, Tim Peierls, Joshua Block, Joseph Bow beer, David Holmes and Doug Lea, "Java Concurrency in Practice", 1st Edition, Addison Wesley, 2006.


**ONLINE RESOURCES:**


1. Elsevier Science -The Art of Multiprocessor Programming, Morgan Kaufmann, September 8, 2020 ISBN: 9780123914064
2. https://www.researchgate.net/publication/213876653_The_Art_of_Multiprocessor_Programming #fullTextFileContent
3. The Art of Multiprocessor Programming DOI: 10.1145/1146381.1146382 Source DBLP, Publisher: Elsevier, Inc.
4. Concurrent Programming: Algorithms, Principles, and Foundations | SpringerLink

**26CSE113**

## DATA VISUALIZATION LAB
**(Professional Elective-II Lab)**

| | |
|---|---|
| Instruction | 3 P Hours per Week |
| Duration of Semester End Examination | - |
| Semester End Examination | - |
| Continuous Internal Evaluation | 50 Marks |
| Credits | 1.5 |

**PREREQUISITE:** Python Programming

**COURSE OBJECTIVES:** This course aims to
1. Develop skills to create basic and advanced data visualizations using modern tools.
2. Enable students to perform data preprocessing and transformation for visualization.
3. Provide hands-on experience in analyzing patterns, trends, and relationships.
4. Train students to design interactive dashboards and visual analytics solutions.
5. Enhance ability to communicate insights through visual storytelling.

**COURSE OUTCOMES:** After completion of this course, students will be able to
1. Create basic charts to represent quantitative data effectively
2. Apply statistical visualization techniques to analyze distributions and relationships
3. Perform data preprocessing and transformation for visualization tasks
4. Develop interactive dashboards using visualization tools
5. Interpret and present insights using advanced visualization techniques

**CO-PO Articulation Matrix**

| PO / CO | PO 1 | PO 2 | PO 3 | PO 4 |
|---|---|---|---|---|
| **CO 1** | 3 | 3 | 1 | 1 |
| **CO 2** | 3 | 3 | 1 | 1 |
| **CO 3** | 3 | 2 | 1 | 2 |
| **CO 4** | 3 | 1 | 2 | 1 |
| **CO 5** | 3 | 1 | 1 | 2 |

**LAB EXPERIMENTS:**
1. Basic Chart Creation Create: Bar charts, Line graphs, Pie charts, Use appropriate labels, legends, and titles, Compare effectiveness of different chart types.
2. Distribution Visualization Generate: Histograms, Box plots, Density (KDE) plots, Analyze spread, skewness, and outliers.
3. Scatter Plots and Relationship Analysis Create scatter plots for two variables, Add regression line (trend line), Interpret correlation patterns.
4. Heatmaps and Correlation Matrix, Compute correlation matrix, Visualize using heatmaps Identify strong/weak relationships.
5. Time-Series Visualization ,Plot time-series data using line charts, Identify trends and seasonality , Apply moving averages.
6. Data Cleaning and Transformation Handle missing values, Perform filtering and aggregation Normalize and transform data.
7. Multivariate Visualization Create Pair plots, Bubble charts, Analyze multiple variables simultaneously.
8. Geospatial Visualization Plot geographical data on maps, Create choropleth maps, Interpret regional patterns.
9. Interactive Visualization Create interactive plots using: Plotly / Power BI, Add filters, tooltips, and drill-down features.

10. Dashboard Development Design a dashboard combining multiple charts Include KPIs and summary insights, Apply design principles (clarity, layout, color usage).
11. Mini Project (Real Dataset) Select a real-world dataset Perform: Data preprocessing, Visualization, Insight generation, Present findings using charts/dashboard.

## TEXT BOOKS:


1. Jake VanderPlas, "Python Data Science Handbook", 1st Edition, O'Reilly Media, 2016.
2. Claus O. Wilke, "Fundamentals of Data Visualization", 1st Edition, O'Reilly Media, 2019.


## SUGGESTED READING:


1. Wes McKinney, "Python for Data Analysis: Data Wrangling with Pandas, NumPy, and Python", 2nd Edition, O'Reilly Media, 2018.
2. Cole Nussbaumer Knaflic, "Storytelling with Data", 1st Edition, Wiley, 2015.
3. Scott Murray, "Interactive Data Visualization for the Web", 2nd Edition, O'Reilly Media, 2017.


## ONLINE RESOURCES:

1. NumPy User Guide – https://numpy.org/doc/stable/user/index.html
2. Pandas Documentation – https://pandas.pydata.org/
3. Matplotlib Documentation – https://matplotlib.org/stable/contents.html
4. Seaborn Documentation – https://seaborn.pydata.org/
5. Microsoft Power BI Learning – https://learn.microsoft.com/en-us/power-bi/
6. Tableau Learning Resources – https://www.tableau.com/learn
7. Coursera – Data Analysis with Python – https://www.coursera.org/learn/data-analysis-with-python
8. GitHub – Data Visualization Resources – https://github.com/clauswilke/dataviz

**26CSE114**

## SOFTWARE DEFINED NETWORKS LAB
**(Professional Elective-II Lab)**

| | |
|---|---|
| Instruction | 3 P Hours per Week |
| Duration of Semester End Examination | - |
| Semester End Examination | - |
| Continuous Internal Evaluation | 50 Marks |
| Credits | 1.5 |

**PREREQUISITES:** Computer Networks, Operating Systems, Programming and Scripting, Network security

**COURSE OBJECTIVES:** This course aims to
1. Equip students with the necessary skills, knowledge, and practical experience to understand, design, implement, and manage software-defined networks.
2. Students will gain a deep understanding of SDN principles, protocols, and applications, preparing them for real-world networking challenges in modern software-defined environments.
3. Provide a hands-on learning environment where students or researchers can gain practical experience with SDN concepts, technologies, and protocols.

**COURSE OUTCOMES:** After the completion of this course, the student will be able to
1. Proficient in installing, configuring and managing SDN controllers such as OpenDaylight, Ryu, or ONOS.
2. Design and configure SDN network topologies using tools like Mininet or Open vSwitch.
3. Define flow rules, match packets based on different criteria, and program switches to forward traffic according to desired policies.
4. Understand how to dynamically route traffic, prioritize specific types of traffic, and enforce QoS policies using SDN controllers.
5. Understand how SDN can be applied to solve specific networking challenges.

**CO-PO Articulation Matrix**

| PO / CO | PO 1 | PO 2 | PO 3 | PO 4 |
|---|---|---|---|---|
| **CO 1** | 3 | - | 2 | - |
| **CO 2** | 3 | - | 2 | - |
| **CO 3** | 3 | 2 | - | - |
| **CO 4** | 3 | - | 3 | 3 |
| **CO 5** | 3 | - | 3 | 2 |

1-Slightly, 2-Moderately, 3-Substantially

**LIST OF EXPERIMENTS:**
1. Install Mininet and OpenFlow controller software on Ubuntu Linux.
2. Launch Mininet using a virtual machine with the virtual switches and hosts.
3. Create the topology of the virtual network using commands in Mininet.
4. Implement MAC learning switch logic in controller in Mininet.
5. Develop controller to block traffic between specific hosts in Mininet
6. Install the OpenFlow controller software.
7. Configure the OpenFlow controller to manage the virtual network created in program 3.
8. Test connectivity between hosts in the virtual network.
9. Configure network services such as Quality of Service (QoS), security policies, and firewall rules using OpenFlow rules.

10. Monitor network statistics using controller.
11. Modify the network topology and observe how the changes impact the network performance and traffic flow.
12. Monitor network statistics using controller using Ryu.

**TEXT BOOKS:**


1. Kirk Byers, “Software Defined Networking: Design and Deployment”, 1st Edition, O’Reilly Media, 2014
2. Benjamin Lerner and David Mahler, “Mastering Mininet", 1st Edition, Packt Publishing, 2015.


**SUGGESTED READING:**


1. "OpenFlow: Switch Specification" by the Open Networking Foundation. (https://opennetworking.org/wp-content/uploads/2014/10/openflow-switch-v1.5.1.pdf)- 2014.
2. Brent Salisbury, Bob Lantz, and Rajdeep Dua, “OpenFlow Cookbook", 1st Edition, Packt Publishing, 2015.


**ONLINE RESOURCES:**

1. https://mininet.org/
2. https://github.com/mininet/openflow-tutorial.
3. https://ryu.readthedocs.io/
4. http://www.projectfloodlight.org/floodlight/
5. https://www.opennetworking.org/

**26CSE115**

## NETWORK SECURITY LAB
**(Professional Elective-II Lab)**

| | |
|---|---|
| Instruction | 3 P Hours per Week |
| Duration of Semester End Examination | - |
| Semester End Examination | - |
| Continuous Internal Evaluation | 50 Marks |
| Credits | 1.5 |

**PREREQUISITE:** Basic knowledge of Computer Networks, Fundamentals of Cryptography, Basic Linux commands

**COURSE OBJECTIVES:** This course aims to
1. Provide hands-on experience in implementing cryptographic algorithms.
2. Understand network vulnerabilities and perform basic security analysis.
3. Configure and analyze network security tools and protocols.
4. Implement firewall, IDS/IPS, and secure communication techniques.
5. Explore real-world cybersecurity tools and case studies.

**COURSE OUTCOMES:** After the completion of this course, the student will be able to
1. Implement basic cryptographic algorithms and security techniques.
2. Analyze network traffic and identify security threats.
3. Configure security tools such as firewalls and intrusion detection systems.
4. Demonstrate secure communication using protocols like SSL/TLS and SSH.
5. Evaluate network vulnerabilities using penetration testing tools.

**CO-PO Articulation Matrix**

| PO / CO | PO1 | PO2 | PO3 | PO4 |
|---|---|---|---|---|
| **CO 1** | 3 | 3 | 2 | 2 |
| **CO 2** | 3 | 3 | 2 | 2 |
| **CO 3** | 3 | 3 | 3 | 2 |
| **CO 4** | 3 | 3 | 3 | 2 |
| **CO 5** | 3 | 3 | 3 | 2 |

1-Slightly, 2-Moderately, 3-Substantially

**LIST OF EXPERIMENTS:**

**PART – A: Cryptography & Basics**
1. Implementation of Caesar Cipher and Monoalphabetic Cipher
2. Implementation of Playfair Cipher / Hill Cipher
3. Implementation of RSA Algorithm

**PART – B: Network Security Tools**
4. Packet capturing and analysis using Wireshark
5. Network scanning using Nmap
6. Vulnerability scanning using OpenVAS / Nessus

**PART – C: System & Network Security**
7. Configuration of Firewall (iptables / Windows Firewall)
8. Setting up and analyzing Intrusion Detection System (Snort)
9. VPN setup and configuration

**PART – D: Advanced Experiments**

10. Secure communication using SSH and SSL/TLS
11. Web application security testing using OWASP ZAP / Burp Suite

## TEXT BOOKS:


1. William Stallings, "Network Security Essentials: Applications and Standards", 7th Edition. Pearson, 2020.
2. William Stallings, "Cryptography and Network Security: Principles and Practice", 8th Edition. Pearson, 2023.


## SUGGESTED READING:


1. Behrouz A. Forouzan, "Cryptography and Network Security", 3rd Edition, McGraw Hill, 2007.
2. Atul Kahate, "Cryptography and Network Security", 3rd Edition, McGraw Hill, 2013.
3. Eric Cole, "Network Security Bible", 2nd Edition, Wiley, 2011.


## ONLINE RESOURCES:

1. NPTEL – Cyber Security Lab Courses
2. https://owasp.org
3. https://www.kali.org

**26CSC104**

## MINI PROJECT

| | |
|---|---|
| Instruction | 3 P Hours per Week |
| Duration of Semester End Examination | - |
| Semester End Examination | - |
| Continuous Internal Evaluation | 50 Marks |
| Credits | 1.5 |

**PREREQUISITE**: Programming Languages (Front-end and Back-end), Software Engineering, Software Project Management

**COURSE OBJECTIVES**: This course aims to

1. Enable students learning by practical realization.
2. Develop capability to analyse and solve real world problems.
3. Develop technical writing and presentation skills.

**COURSE OUTCOMES**: After the completion of this course, the student will be able to

1. Identify unsolved problems in domain space.
2. Demonstrate team work and sound theoretical knowledge on the problem context.
3. Analyze the problem with existing solutions and finalize the scope.
4. Design an optimized solution with flexible architecture to support future functionalities.
5. Demonstrate the knowledge, skills, and attitudes of a professional engineer.

**CO-PO Articulation Matrix**

| CO/PO | PO1 | PO2 | PO3 | PO4 |
|---|---|---|---|---|
| **CO1** | - | 3 | - | - |
| **CO2** | - | - | - | - |
| **CO3** | - | 3 | 3 | - |
| **CO4** | - | - | 3 | 3 |
| **CO5** | - | - | - | - |

1-Slightly, 2-Moderately, 3-Substantially

**GUIDELINES:**

- Students shall work for take 2 to 3 weeks to identify their problem at the beginning of the coursework.
- Each student will be monitored and evaluated by the departmental review team/committee. They are encouraged to work on interdisciplinary or industry-based real-time application problems.
- Each student is advised to demonstrate their work during the scheduled presentation based on their problem statement.
- The student shall clearly state their investigations and document them in the final report

**Departmental Review Committee**: Two or three faculty members are assigned at the time of workload distribution.

| **Guidelines for awarding marks (CIE):** | **Max. Marks: 50** | |
|---|---|---|
| **Evaluation by** | **Max .Marks** | **Evaluation Criteria / Parameter** |
| **Departmental Review Committee** | 20 | Progress and Review |
| | 5 | Report |
| | 5 | Relevance of the Topic |
| | 5 | PPT Preparation |
| | 5 | Presentation |
| | 5 | Question and Answers |
| | 5 | Report Writing |

**CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY**
**R26 (In line with AICTE Model Curriculum) with effect from AY 2026-27**

**M. Tech. (Computer Science and Engineering)**

**SEMESTER – II**

| S. No | Course Code | Title of the Course | Scheme of Instruction | | | Scheme of Examination | | | Credits |
|---|---|---|---|---|---|---|---|---|---|
| | | | Hours per Week | | | Duration of SEE in Hours | Maximum Marks | | |
| | | | L | T | P/D | | CIE | SEE | |
| **THEORY** | | | | | | | | | |
| 1. | 26CSC105 | Cyber Security | 3 | - | - | 3 | 40 | 60 | 3 |
| 2. | 26CSC106 | Distributed Cloud Computing | 3 | - | - | 3 | 40 | 60 | 3 |
| 3. | 26CSC107 | Natural Language Processing | 3 | - | - | 3 | 40 | 60 | 3 |
| 4. | 26CSC108 | Research Methodologies in Computer Science and IPR | 1 | - | - | 1 | 40 | 60 | 1 |
| 5. | 26CSExxx | Professional Elective-III | 3 | - | - | 3 | 40 | 60 | 3 |
| 6. | 26xxxxxx | Audit Course-2 | 2 | - | - | 2 | - | 50 | Non Credit |
| **PRACTICAL** | | | | | | | | | |
| 7. | 26CSC109 | Cyber Security Lab | - | - | 2 | - | 50 | - | 1 |
| 8. | 26CSC110 | Natural Language Processing Lab | - | - | 3 | - | 50 | - | 1.5 |
| 9. | 26CSExxx | Professional Elective-III Lab | - | - | 3 | - | 50 | - | 1.5 |
| **Total** | | | **15** | | **8** | **-** | **350** | **350** | **17** |

**L: Lecture** **D: Drawing** **CIE: Continuous Internal Evaluation**
**T: Tutorial** **P: Practical/Dissertation** **SEE-Semester End Examination**

| Professional Elective – III | |
|---|---|
| 26CSE116 | Generative AI |
| 26CSE117 | Internet of Things |
| 26CSE118 | Artificial Intelligence for Robotics |
| 26CSE119 | Devops Tools |
| 26CSE120 | Web Intelligence |

| Professional Elective – III Lab | |
|---|---|
| 26CSE121 | Generative AI Lab |
| 26CSE122 | Internet of Things Lab |
| 26CSE123 | Artificial Intelligence for Robotics Lab |
| 26CSE124 | Devops Tools Lab |
| 26CSE125 | Web Intelligence Lab |

**26CSC105**

## CYBER SECURITY

| | |
|---|---|
| Instruction | 3 L Hours per Week |
| Duration of Semester End Examination | 3 Hours |
| Semester End Examination | 60 Marks |
| Continuous Internal Evaluation | 40 Marks |
| Credits | 3 |

**PREREQUISITE:** Network Security.

**COURSE OBJECTIVES:** This course aims to

1. Identify and present indicators that a cybercrime has occurred and understand methods and tools used in cybercrimes.
2. Collect, Process, Analyze and Present Computer Forensics Evidence.
3. Understand the legal perspectives and Organizational implications of Cyber Security.

**COURSE OUTCOMES:** After completion of this course, students will be able to

1. List the different types of cybercrimes and analyze legal frameworks to handle cybercrimes.
2. Discuss the cyber offence and vulnerabilities in programming languages.
3. Identify the Tools and Methods used in cybercrimes.
4. Analyze and resolve cyber security issues and laws governing Cyberspace.
5. Describe the need of Digital Forensics and the importance of digital evidence in prosecution.

**CO-PO Articulation Matrix**

| PO / CO | PO 1 | PO 2 | PO 3 | PO 4 |
|---|---|---|---|---|
| **CO 1** | 3 | 2 | - | 2 |
| **CO 2** | 2 | 2 | 2 | 2 |
| **CO 3** | - | - | 3 | 3 |
| **CO 4** | 2 | 3 | 2 | 2 |
| **CO 5** | 3 | - | 3 | 2 |

1-Slightly, 2-Moderately, 3-Substantially

**UNIT-I**

**Foundations of Cyber Crime & Security:** Cyber Crime: Definition and origins, Cybercrime and Information Security, Classification of Cyber rimes, Cyber Crime: Legal Perspective, Cyber Crime: Indian Perspective. Evolution of Cyber Threat Landscape, Types of Threat Actors (Hacktivists, APTs, Cyber Terrorists), Cyber Warfare and Critical Infrastructure Attacks.

**UNIT-II**

**Cyber Offenses and Attack Mechanisms:** How criminals plan attacks, Social Engineering, Cyber Stalking, Cyber Cafes and Cybercrimes, Botnets and Attack Vectors, Buffer Overflow, How Browsers Work, Google Dorking, Masscan and Shodan, Web Security, Cyber Kill Chain Model, Advanced Social Engineering (Spear Phishing, Vishing), Browser Security Models (Same-Origin Policy, Cookies, Sessions), OSINT (Open Source Intelligence) Techniques.

**UNIT-III**

**Tools and Techniques in Cybercrime:** Proxy Servers and Anonymizers, Phishing, Password Cracking, Keyloggers and Spyware, Virus and Worms, Trojan Horse and Backdoors, Steganography, DoS and DDoS Attacks, Injection Attacks and SQL Injection, Ransomware, Cross-Site Scripting (XSS), ARP Spoofing, SYN Floods, Foot printing, IP Scanner, Port Scanner, Vulnerability Scanner, VPN and TOR Network for Anonymity Credential Stuffing and Rainbow Table Attacks, Malware Analysis Basics (Static & Dynamic), Penetration Testing Methodology.

**UNIT-IV**

**Cyber Laws and Governance:** Cyber Crime and Global Legal Landscape, Need for Cyber Laws (Indian Context), IT Act and Amendments, Strengths and Weaknesses of IT Act, International Regulations (GDPR Overview), Role of CERT-In and Cyber Governance Bodies, Cyber Ethics and Privacy Issues, Legal Aspects of Digital Evidence.

**UNIT-V**

**Cyber Forensics and Incident Response:** Introduction to Cyber Forensics, Need for Computer Forensics, Digital Evidence, Email Forensics, Digital Forensics Lifecycle, Chain of Custody. Incident Response Framework (Preparation–Detection–Response–Recovery), Memory and Disk Forensics, Cyber Incident Impact Analysis and Risk Management, AI in Cybersecurity and Forensics.

## TEXT BOOKS:


1. Sunit Belpre and Nina Godbole, "Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives", 1st Edition, Wiley India Pvt.Ltd, 2011.
2. Malcolm McDonald "Web Security for Developers", 1st Edition, No Starch Press, 2020, 216 pp. ISBN-13: 9781593279943.


## SUGGESTED READING:


1. Daniel G. Graham "Ethical Hacking: A Hands-on Introduction to Breaking in", 1st Edition, No Starch Press. October 2021, 376 pp. ISBN13: 9781718501874.
2. Kevin Mandia, Chris Prosise, "Incident Response and computer forensics", 1st Edition, Tata McGraw Hill, 2006.
3. Alfred Basta, Nadine Basta, Mary Brown, Ravinder Kumar, "Cyber Security and Cyber Laws",, 1st Edition, Cengage India Private Limited, Paperback – 2018.


## ONLINE RESOURCES:

1. https://onlinecourses.swayam2.ac.in/nou19_cs08/preview
2. https://onlinecourses.swayam2.ac.in/cec20_cs15/preview

**26CSC106**

## DISTRIBUTED CLOUD COMPUTING

| | |
|---|---|
| Instruction | 3 L Hours per Week |
| Duration of Semester End Examination | 3 Hours |
| Semester End Examination | 60 Marks |
| Continuous Internal Evaluation | 40 Marks |
| Credits | 3 |

**PREREQUISITE**: Computer Organization Architecture, Computer Networks and Virtualization.

**COURSE OBJECTIVES:** This course aims to

1. Provide a fundamental understanding of the transition from classical networked systems to scalable Distributed and Cloud architectures.
2. Impart in-depth knowledge of Virtualization technologies and the internal mechanics of Virtual Machine Monitors (VMMs).
3. Explore complex Resource Management models, including combinatorial auctions and utility-based scheduling in multi-tenant environments.
4. Analyze Parallel Programming models like MapReduce and coordination services like ZooKeeper for large-scale data processing.
5. Sensitize students to the Security and Privacy implications of shared infrastructure and the design of trusted execution environments.

**COURSE OUTCOMES:** After the completion of this course, the student will be able to

1. Compare various distributed architectural styles and their application in Edge-Cloud environments.
2. Design and implement coordination logic for distributed activities using state-machine models of ZooKeeper and MapReduce paradigms.
3. Analyze the performance and isolation characteristics of Full Virtualization, Para-virtualization, and hardware-assisted virtualization.
4. Evaluate cloud scheduling algorithms (Fair Queuing, BVT) and resource bundling strategies based on deadline constraints and utility models
5. Assess security risks associated with shared management OS, virtual machine images, and the implementation of Trusted VMMs

**CO-PO Articulation Matrix**

| PO / CO | PO 1 | PO 2 | PO 3 | PO 4 |
|---|---|---|---|---|
| **CO 1** | 2 | 1 | 1 | 1 |
| **CO 2** | 2 | - | 1 | - |
| **CO 3** | 1 | - | 2 | 2 |
| **CO 4** | 1 | 2 | 2 | 3 |
| **CO 5** | 2 | 2 | 3 | 3 |

1-Slightly, 2-Moderately, 3-Substantially

**UNIT-I**

**Introduction**: From networked systems to distributed systems, Design goals, and a simple classification of distributed systems. **Architectures:** Architectural styles, Middleware and distributed systems, layered system architectures, symmetrically distributed system architectures. **Hybrid system architectures**: Cloud computing, the edge-cloud architecture.

**UNIT-II**

**Cloud Computing-Applications and Paradigms:** Challenges for Cloud Computing, Existing Cloud Applications and New Application Opportunities, Architectural Styles for Cloud Applications. Workflows: Coordination of Multiple Activities, Coordination Based on a State Machine Model: The Zookeeper, the MapReduce Programming Model.

**UNIT-III**

**Cloud Resource Virtualization:** Virtualization, Layering and Virtualization, Virtual Machine Monitors, Virtual Machines, Performance and Security Isolation, Full Virtualization and Para virtualization Hardware Support for Virtualization

**UNIT-IV**

**Cloud Resource Management and Scheduling:** A Utility-Based Model for Cloud-Based Web Services, Resource Bundling: Combinatorial Auctions for Cloud Resources Scheduling Algorithms for Computing Cloud, Fair Queuing, Start-Time Fair Queuing, Borrowed Virtual Time, Cloud Scheduling Subject to Deadlines, Scheduling MapReduce Applications Subject to Deadlines, Resource Management and Dynamic Application Scaling.

**UNIT-V**

**Cloud Security:** Cloud Security Risks, Security: The Top Concern for Cloud Users, Privacy and Privacy Impact Assessment, Trust, Operating System Security, Virtual Machine Security, Security of Virtualization, Security Risks Posed by Shared Images .Security Risks Posed by a Management OS, A Trusted Virtual Machine Monitor.

## TEXT BOOKS:


1. Maarten van Steen, Andrew S. Tanenbaum “Distributed Systems”, 4th Edition, Maarten van Steen 2023.
2. Dan C. Marinescu, “Cloud Computing Theory and Practice”, 3rd Edition, Morgan Kaufmann Publishers 2022.


## SUGGESTED READING:


1. Lisdorf, Anders “Cloud Computing Basics: A Non-Technical Introduction”, 1st Edition, A Press, 2021.
2. George Coulouris, Jean Dollimore, Tim Kindberg, Gordon Blair, “Distributed Systems Concepts and Design”, 5th Edition, Pearson, 2017.
3. Hwang, Geoffrey C. Fox, Jack G. Dongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", 1st Edition, Morgan Kaufmann Publishers, 2012.


## ONLINE RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc21_cs15/preview
2. https://onlinecourses.nptel.ac.in/noc25_cs130/preview
3. https://onlinecourses.nptel.ac.in/noc21_cs14/preview

**26CSC107**

## NATURAL LANGUAGE PROCESSING

| | |
|---|---|
| Instruction | 3 L Hours per Week |
| Duration of Semester End Examination | 3 Hours |
| Semester End Examination | 60 Marks |
| Continuous Internal Evaluation | 40 Marks |
| Credits | 3 |

**PREREQUISITE**: Python Programming language or similar, Basics of Statistics and Probability, Basics of Linear Algebra, Basics of Machine Learning.

**COURSE OBJECTIVES:** This course aims to

1. Introduce foundational concepts of NLP, including linguistic principles, mathematical frameworks, and challenges in processing human and Indian languages.
2. Develop understanding of ML and DL techniques for NLP, including neural networks, vector representations, and language modelling.
3. Enable the design and application of modern NLP models, including transformers and pre-trained models, for real-world tasks like text classification and question answering.

**COURSE OUTCOMES:** After the completion of this course, the student will be able to

1. Understand and explain the fundamentals of NLP, including linguistic structures, probabilistic models, and challenges in processing natural language data.
2. Apply machine learning and neural network techniques such as perceptrons, feedforward networks, and recurrent neural networks for NLP tasks.
3. Analyze and implement vector semantics and word embedding techniques.
4. Design and evaluate language models and sequence-based architectures for applications like text classification and sequence tagging.
5. Utilize transformer-based architectures and pre-trained models for advanced NLP applications such as question answering, summarization, and multilingual processing.

**CO-PO Articulation Matrix**

| PO / CO | PO 1 | PO 2 | PO 3 | PO 4 |
|---|---|---|---|---|
| **CO 1** | 3 | - | - | - |
| **CO 2** | 3 | 2 | - | 2 |
| **CO 3** | 3 | 3 | - | 2 |
| **CO 4** | 3 | - | 3 | 2 |
| **CO 5** | 3 | - | 3 | 3 |

1-Slightly, 2-Moderately, 3-Substantially

**UNIT- I**

**Introduction** to Natural Language Processing, Origins of NLP, Language and Knowledge, The Challenges of NLP, Language and Grammar, Processing Indian Languages, NLP Applications.

**Basic Mathematical Machinery:** Linear Algebra, Probability, Information Theory, etc., Basic Linguistic Machinery, Phonology, morphology, syntax, semantics.

**UNIT-II**

**Introducing Neural Computation:** Perceptrons, Feedforward Neural Network and Backpropagation, Recurrent Neural Nets.

**Classical ML/DL:** Representation, Symbolic Representation, Distributed Representation, Compositionality; Parametric and non-parametric learning.

**UNIT-III**

**Vector Semantics and Embedding:** Lexical semantics, vector semantics, Distributional Semantics, words and vectors, TF-IDF: weighting terms in vector and applications, Learning Word Embeddings: Word2Vec (CBOW and Skip Gram), Glove, FastText.

**Application of Word Embedding to Shallow Parsing:** Morphological Processing, Part of Speech Tagging and Chunking.

**UNIT-IV**

**Language Modeling**, Recurrent Neural Networks (RNNs) based Language Modeling, LSTMs, GRU RNNs for Sequence Tagging, Text Classification, Sequence to Sequence.

**UNIT-V**

**Transformers and Pretraining:** Transformer Architecture and Functioning, Attention, Positional Encoding, Layer Normalization, Applications in Sentiment Analysis, Image Labelling etc., BERT, GPT, BART, T5.

**Applications:** Question Answering, Summarization, Dialog Modeling, Analysis and Interpretability, Prompt-based methods, low-resource and multilingual NLP

## TEXT BOOKS:


1. Daniel Jurafsky and James H. Martin, "Speech and Language Processing", 3rd Edition, Pearson Publisher 2021.
2. Christopher Manning and Heinrich Schutze, "Foundations of Statistical Natural Language Processing", 1st Edition, MIT Press, 1999.


## SUGGESTED READING:


1. Dan Jurafsky and James Martin, "Speech and Language Processing", 3rd Edition, Pearson Publisher 2019.
2. Pushpak Bhattacharyya, "Machine Translation", 1st Edition, CRC Press, 2017.
3. Ian Goodfellow, Yoshua Bengio, and Aaron Courville, "Deep Learning", 1st Edition, MIT Press, 2016.


## ONLINE RESOURCES:

1. Yoav Goldberg. A Primer on Neural Network Models for Natural Language Processing Online.
2. https://www.simplilearn.com/learn-basics-of-natural-language-processing-free-course-skillup nptel.ac.in/courses/106105158

**26CSC108**

## RESEARCH METHODOLIGIES IN COMPUTER SCIENCE AND IPR

| | |
|---|---|
| Instruction | 1 L Hours per Week |
| Duration of Semester End Examination | 1 Hours |
| Semester End Examination | 60 Marks |
| Continuous Internal Evaluation | 40 Marks |
| Credits | 1 |

**PREREQUISITES:** Basic mathematics, statistics**.**

**COURSE OBJECTIVES:** This course aims to

1. Understand the research process.
2. Solve unfamiliar problems using scientific procedures.
3. Pursue ethical research.
4. Use appropriate tools for documentation and analysis of data.

**COURSE OUTCOMES:** After the completion of this course, the student will be able to

1. Understand research problem formulation.
2. Design experiments.
3. Analyze research related information.
4. Write papers and thesis, Follow research ethics.
5. Use tools for analysis and thesis writing.

**CO-PO Articulation Matrix**

| PO / CO | PO 1 | PO 2 | PO 3 | PO 4 |
|---|---|---|---|---|
| **CO 1** | 2 | 3 | - | 1 |
| **CO 2** | 3 | 2 | 1 | 2 |
| **CO 3** | 3 | 2 | 1 | 1 |
| **CO 4** | 3 | 3 | 1 | 2 |
| **CO 5** | 3 | 2 | 1 | 2 |

1-Slightly, 2-Moderately, 3-Substantially

**UNIT-I**

**Research Process:** Meaning of Research, Objectives and Motivation of Research, Technological Innovation, Types of Research, Research Vs Scientific method, Research Methodology vs Research Methods, Research process. Research Problem Formulation: Problem solving in Engineering, Identification of Research Topic, Problem Definition, Literature Survey, Literature Review.

**Research Design:** Research Design: What it is? Why we need Research Design? Terminology and Basic Concepts, Different Research Designs, Experimental Designs.

**UNIT-II**

**Mathematical Modeling:** Models in General, Mathematical Model, Model Classification, Modelling of Engineering Systems. Probability and Distributions: Importance of Statistics to Researchers, Probability Concepts, Probability Distributions, Popular Probability Distributions, Sampling Distributions. Sample Design and Sampling: Sample design, Types of sample designs, The Standard Error, Sample Size for Experiments, Prior Determination Approach.

**UNIT-III**

**Design of Experiments and Regression Analysis:** Design of Experiments, Planning of Experiments, Multivariate Analysis, Simple Regression and Correlation, Multiple Regression and Correlation Analysis and Interpretation of Data: Introduction, Data Checking, Data Analysis, Interpretation of Results, Guidelines in Interpretations. Accuracy, Precision and Error Analysis: Introduction,

Repeatability and Reproducibility, Error Definition and Classification, Analysis of Errors, Statistical Analysis of Errors, Identification of Limitations.

**UNIT-IV**

**Writing of Papers and Synopsis:** Introduction, Audience Analysis,, Preparing Papers for Journals, Preparation of Synopsis of Research Work Thesis Writing Mechanics: Introduction, Audience for Thesis Report, Steps in Writing the report, Mechanics of Writing, Presentation of graphs, figures and tables.

**UNIT-V**

**Ethics in Research:** Importance of Ethics in Research, Integrity in Research, Scientific Misconduct and Consequences. Spreadsheet tool: Introduction, Quantitative Data Analysis Tools, Entering and preparing your data, Using statistical functions, Loading and using Data Analysis Tool Pack [Tools: Microsoft Excel / Open office]Thesis writing & scientific editing tool[Tool: Latex]:

## TEXT BOOKS:


1. R.Ganesan, "Research Methodology for Engineers", 1st Edition, MJP Publishers; Chennai, 2011.
2. Paul R Cohen, "Empirical Methods in AI", 1st Edition, PHI, New Delhi, 2004.
3. C.R.Kothari, "Research Methodology, Methods & Technique", 2nd Edition, New age International Publishers, 2004.


## SUGGESTED READING:


1. Kumar, Ranjit, "Research Methodology - A Step-by-Step Guide for Beginners", 2nd Edition, Pearson Education, 2005
2. "LaTEX for Beginners Workbook", 5th Edition, xx Publisher, 2014.


## ONLINE RESOURCES:

1. https://nptel.ac.in/courses/121106007

**26CSE116**

## GENERATIVE AI
**(Professional Elective-III)**

| | |
|---|---|
| Instruction | 3 L Hours per Week |
| Duration of Semester End Examination | 3 Hours |
| Semester End Examination | 60 Marks |
| Continuous Internal Evaluation | 40 Marks |
| Credits | 3 |

**PREREQUISITE:** Knowledge on Elements of Electrical Engineering.

**COURSE OBJECTIVES:** This course aims to
1. Introduce the foundations, evolution, and core concepts of AI, ML, DL, NLP, and Generative AI.
2. Develop understanding of advanced neural architectures and generative models such as GANs, VAEs, and Transformers.
3. Explore Large Language Models, prompt engineering, and their real-world applications.
4. Familiarize learners with frameworks, multimodal applications, and ethical considerations in Generative AI.

**COURSE OUTCOMES:** After the completion of this course, the student will be able to
1. Understand the fundamentals of Artificial Intelligence, Machine Learning, Deep Learning, and Generative AI, including neural network structures and generative modelling concepts.
2. Analyze and apply advanced neural architectures such as Variational Autoencoders (VAEs), Generative Adversarial Networks (GANs), Transformers, and LSTMs for generative tasks.
3. Design and implement applications using Large Language Models (LLMs) such as GPT and BERT, and apply prompt engineering and fine-tuning techniques.
4. Apply multi-agent systems and orchestration frameworks to develop collaborative generative AI solutions across real-world domains
5. Develop end-to-end generative AI applications using frameworks like LangChain and RAG, and evaluate ethical, social, and legal implications of AI systems.

**CO-PO Articulation Matrix**

| PO / CO | PO 1 | PO 2 | PO 3 | PO 4 |
|---|---|---|---|---|
| **CO 1** | 2 | 2 | 1 | - |
| **CO 2** | 3 | 2 | 2 | - |
| **CO 3** | 3 | 2 | 2 | 1 |
| **CO 4** | 2 | 2 | 2 | - |
| **CO 5** | 3 | 2 | 2 | 2 |

1-Slightly, 2-Moderately, 3-Substantially

**UNIT-I**

**Foundations of AI and Generative Models:** Introduction and historical evolution to Artificial Intelligence (AI), Machine Learning (ML), Natural Language Processing (NLP) and Deep Learning (DL), Structure of Artificial Neural Networks (ANNs),
Mathematical and computational foundations of generative modeling, Overview of generative model and their applications across various domains; Importance of Generative AI in modern applications, Transfer learning and in advancing Generative AI.

**UNIT-II**

**Advanced Neural Architectures for Generative AI** : Variational Autoencoders (VAEs): principles and applications, Generative Adversarial Networks (GANs): architecture and working principles; Transformer architecture and attention mechanisms (in detail); Advanced Transformer architectures and techniques, Pre-training and transfer learning strategies for generative models

**UNIT-III**

**Large Language Models and Prompt Engineering :** Overview of Large Language Models (LLMs), GPT architecture, variants, and working principles, Prétraining and fine-tuning GPT models for applications (e.g., chatbots, text generation), Case study: GPT-based customer support chatbot, BERT architecture, pre-training objectives, and fine-tuning, Prompt Engineering: Designing effective prompts, controlling model behavior, and improving output quality, Fine-tuning language models for creative writing and chatbot development

**UNIT-IV**

**Multi-Agent Systems and Generative AI Applications:** Introduction to Multi-Agent Systems (MAS),Types of agents: reactive, deliberative, hybrid, and learning agents, Multi-agent collaboration and orchestration for generative tasks, Use cases: autonomous research assistants, cooperative creative generation, distributed problem-solving, Frameworks and tools: AutoGen, CrewAI, Hugging GPT for LLM-powered multi-agent systems, Generative AI applications: Art, Creativity, Image/Video generation, Music composition, Healthcare, Finance, Real-world case studies and deployment challenges

**UNIT-V**

**LangChain framework:** components and LLM application development, Retrieval-Augmented Generation (RAG), Embeddings, Indexing networks, and Vector databases, Generative AI across modalities: Text, Code, Image, and Video generation, Image and Video generation using GANs and VAEs, Multimodal Generative AI: integration and training strategies, Ethical considerations: bias, fairness, trust, and responsible AI deployment, Social and legal implications of Generative AI, Risk mitigation strategies and real-world ethical case studies

## TEXT BOOKS:


1. Altaf Rehmani, “Generative AI for Everyone: Understanding the Essentials and Applications of This Breakthrough Technology”, 1st Edition, Pearson, 2024.
2. Charu C. Aggarwal, “Neural Networks and Deep Learning: A Textbook”, 1st Edition, Springer, 2018.


## SUGGESTED READING:


1. Josh Kalin, “Generative Adversarial Networks Cookbook”, 1st Edition, Packt Publishing, 2018.
2. Jesse Sprinter, “Generative AI in Software Development: Beyond the Limitations of Traditional Coding”, Amazon Digital Services LLC - Kdp, 2024.


## ONLINE RESOURCES:

1. nptel.ac.in/courses/106108703
2. https://onlinecourses.swayam2.ac.in/e-learning/preview/nou25_ma05

**26CSE117**

## INTERNET OF THINGS
**(Professional Elective-III)**

| | |
|---|---|
| Instruction | 3 L Hours per Week |
| Duration of Semester End Examination | 3 Hours |
| Semester End Examination | 60 Marks |
| Continuous Internal Evaluation | 40 Marks |
| Credits | 3 |

**PREREQUISITE**: Computer Architecture and Micro Processor, Programming for Problem Solving.

**COURSE OBJECTIVES:** This course aims to
1. Understand the individual components of IoT.
2. Impart necessary and practical knowledge in Internet of Things.
3. Develop skills required to build real-time IIoT based projects.

**COURSE OUTCOMES:** After the completion of this course, the student will be able to
1. Understand Internet of Things and IIOT basics components.
2. Illustrate working of I/O devices, sensors & communication module.
3. Analyse the use of protocols in IoT.
4. Interface I/O devices, Sensors and communication module
5. Develop real time IoT based projects.

**CO-PO Articulation Matrix**

| PO / CO | PO1 | PO2 | PO3 | PO4 |
|---|---|---|---|---|
| **CO 1** | - | - | 1 | 1 |
| **CO 2** | 1 | - | 1 | 1 |
| **CO 3** | 1 | - | 1 | 1 |
| **CO 4** | 1 | - | 2 | 2 |
| **CO 5** | 3 | - | 3 | 3 |

1-Slightly, 2-Moderately, 3-Substantially

**UNIT- I**

**Internet of Things an Overview:** Introduction to Internet of Things, IoT Conceptual Framework, IoT Architectural View, Technology behind IoT, Sources of IoT, M2M Communication, Examples of IoT. **Design Principles for Connected Devices:** IoT/M2M System Layers and Design Standardisation, Communication Technologies, Data Enrichment, Device consolidation, Data Management at Gateway.

**UNIT-II**

**IoT Physical Devices and Endpoints:** What is an IoT Device, Exemplary Device: Raspberry Pi, About the Board, Linux on Raspberry Pi, Raspberry Pi Interfaces, and Programming Raspberry Pi with Python.

**UNIT-III**

**IoT data protocols:** MQTT, CoAP, AMQP, DDS, HTTP, WebSocket.
**Network Protocols for IoT:** 6LowPAN, RPL, WiFi, Bluetooth, ZigBee, Z-Wave, LoRaWan.

**UNIT-IV**

**Modern networking:** Cloud computing: Introduction to the Cloud Computing, History of cloud computing, Cloud Service options, Cloud Deployment models, Business concerns in the cloud, Hypervisors, Comparison of Cloud Providers, Cloud and Fog Ecosystem for IoT Review of architecture.

**Data Acquiring, Organising, Processing and Analytics**: Introduction, Data Acquiring and Storage, Organizing the Data, Transactions, Business Processes, Integration and Enterprise System, Analytics, Knowledge Acquiring, Managing and Storing Processes.

**UNIT-V**

**Case Studies:** Home Automation, Cities, Environment, Agriculture, Productivity Applications

## TEXT BOOKS:


1. Arsheep Bahga, Vijay Madisetti, "Internet of Things: A Hands-On Approach Paperback", 1st Edition, Universities Press, Reprint 2020.
2. Raj Kamal, "Internet of Things, Architecture and Design Principles", 1st Edition, McGraw Hill Education, Reprint 2018.


## SUGGESTED READING:


1. Pethuru Raj, Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", 1st Edition, CRC Press, 2022.
2. Perry Lea, "Internet of Things for Architects: Architecting IoT solutions by implementing sensors, communication infrastructure, edge computing, analytics, and security", 1st Edition, Packt Publications, Reprint 2018.
3. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, "IoT Fundamentals Networking Technologies, Protocols, and Use Cases for the Internet of Things", 1st Edition, CISCO Press, 2017.


## ONLINE RESOURCES:

1. https://owasp.org/www-project-internet-of-things/
2. NPTEL: Sudip Misra, IIT Khargpur, Introduction to IoT: Part-1, https://nptel.ac.in/courses/106/105/106105166/
3. https://www.coursera.org/in/articles/internet-of-things

**26CSE118**

## ARTIFICIAL INTELLIGENCE FOR ROBOTICS

**(Professional Elective-III)**

| | |
|---|---|
| Instruction | 3 L Hours per week |
| Duration of Semester End Examination | 3 Hours |
| Semester End Examination | 60 Marks |
| Continuous Internal Evaluation | 40 Marks |
| Credits | 3 |

**PREREQUISITE:** Basics of AI

**COURSE OBJECTIVES:** This course aims to

1. Understand the foundation for robotics and AI.
2. Learn the real-time problem solving with AI enabled robots.
3. Gain the knowledge on hardware and software aspects of AI enabled robots.
4. Explore the real world applications of AI enabled robots.
5. Learn the associated technologies for building sophisticate robots to solve complex problems.

**COURSE OUTCOMES:** After the completion of this course, the student will be able to

1. Understand the Observe-Orient Decide-Act (OODA) AI framework.
2. Analyze the techniques that allow the robot to learn for itself.
3. Explore object recognition methods.
4. Illustrate robot navigation.
5. Analyze Robot Emotion Engine.

**CO-PO Articulation Matrix**

| PO / CO | PO 1 | PO 2 | PO 3 | PO 4 |
|---|---|---|---|---|
| **CO 1** | - | 3 | - | - |
| **CO 2** | - | - | 3 | 2 |
| **CO 3** | - | 3 | - | 2 |
| **CO 4** | - | - | 3 | 2 |
| **CO 5** | - | 3 | - | 3 |

1-Slightly, 2-Moderately, 3-Substantially

**UNIT-I**

**Foundations of Intelligent Robotics:** Introduction to Robotics and Artificial Intelligence.

**Robot Architecture:** Sensors, Actuators, Controllers, Robot Operating System (ROS2) and Middleware, Embedded Systems and Hardware Setup for Robots, Simulation Tools (Gazebo, RViz).

**UNIT-II**

**Perception and Computer Vision:** Fundamentals of Robot Perception, Image Processing and Feature Extraction, Object Detection and Recognition (CNNs, YOLO, R-CNN), 3D Vision and Depth Estimation, Sensor Fusion (Camera, LiDAR, IMU), Supervised and Transfer Learning for Robotics.

**UNIT-III**

**Learning and Intelligent Control:** Machine Learning Basics for Robotics, Reinforcement Learning (Q-Learning, Deep RL), Imitation Learning and Self-learning Robots, Adaptive and Intelligent Control Systems, Speech Recognition and Natural Language Processing for Robots.

**UNIT-IV**

**Navigation and Autonomous Systems:** Localization and Mapping (SLAM – EKF, Graph-based SLAM), Path Planning Algorithms (A*, Dijkstra, RRT), Obstacle Avoidance Techniques, Multi-

Robot Systems and Swarm Robotics, Decision Making (MDP, Decision Trees, Behaviour Trees), Autonomous Driving Basics.

**UNIT-V**

**Cognitive Robotics and Future Trends:** Cognitive Architectures for Robots, Emotion AI and Artificial Personality in Robots, Conversational AI and Chabot Integration, Ethics, Safety, and Trust in AI Robotics, Explainable AI (XAI) in Robotics.

## TEXT BOOKS:


1. Francis X. Govers III, "Artificial Intelligence for Robotics", 1st Edition, Packt Publishing, 2024.
2. Gang Peng et al., "Introduction to Intelligent Robot System Design: Application Development with ROS", 1st Edition, Springer, 2023.


## SUGGESTED READING:


1. Nikleia Eteokleous, Efi Nisforou, "Designing, Constructing and Programming Robots for Learning", IGI Global, 1st Edition, Publishing, 2021.
2. Lentin Joseph and Jonathan Cacace, "Mastering ROS 2 for Robotics Programming", 4th Edition, Packt Publishing, 2025.
3. Danny Staple, "Learn Robotics Programming", 2nd Edition, Packt Publishing, 2021.


## ONLINE RESOURCES:

1. https://roboticsindia.live/list-of-nptel-robotics-course-2022/
2. https://nptel.ac.in/courses/107106090

**26CSE119**

## DEVOPS TOOLS
**(Professional Elective-III)**

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|---|---|
| Instruction | 3 L Hours per Week |
| Duration of Semester End Examination | 3 Hours |
| Semester End Examination | 60 Marks |
| Continuous Internal Evaluation | 40 Marks |
| Credits | 3 |

**PREREQUISITE**: Knowledge of Software Engineering, Operating Systems, Cloud Computing and Programming Concepts.

**COURSE OBJECTIVES:** This course aims to
1. Provide a comprehensive understanding of the DevOps lifecycle and its significance in modern software development practices.
2. Equip students with practical skills in version control, CI/CD automation, and container-based deployment using modern DevOps tools.
3. Enable students to analyze and implement cloud-based infrastructure, DevSecOps practices, and monitoring techniques for building reliable and scalable systems.

**COURSE OUTCOMES:** After the completion of this course, the student will be able to
1. Explain the DevOps lifecycle and its role in modern software development.
2. Apply version control systems and CI tools to automate development workflows.
3. Implement container-based deployment using Docker and orchestration tools.
4. Analyze cloud-based deployment strategies and infrastructure automation.
5. Evaluate DevSecOps practices and monitoring tools for reliable systems.

**CO-PO Articulation Matrix**

| PO / CO | PO 1 | PO 2 | PO 3 | PO 4 |
|---|---|---|---|---|
| **CO 1** | 1 | 2 | 2 | 1 |
| **CO 2** | 2 | 2 | 3 | 2 |
| **CO 3** | 3 | 1 | 3 | 2 |
| **CO 4** | 3 | 2 | 3 | 3 |
| **CO 5** | 2 | 3 | 3 | 2 |

1-Slightly, 2-Moderately, 3-Substantially

**UNIT - I**

**Introduction to DevOps:** Evolution of software development models: Waterfall, Agile and DevOps. DevOps principles, culture and lifecycle. Agile methodologies: Scrum and Kanban. DevOps tool chain overview. Continuous Integration, Continuous Delivery and Continuous Deployment concepts. Benefits and challenges of DevOps adoption.

**UNIT - II**

**Version Control and Continuous Integration:** Version control concepts. Git architecture, workflow, branching and merging strategies. Repository management using GitHub/GitLab/Bitbucket. Build automation tools such as Maven and Gradle. Continuous Integration pipelines. Jenkins and GitHub Actions. Automated testing in CI pipelines.

**UNIT - III**

**Containerization and Configuration Management:** Virtualization vs Containerization. Docker architecture, images, containers and Dockerfiles. Docker Compose and container networking. Container registries. Configuration management concepts. Infrastructure as Code (IaC). Tools: Ansible, Puppet and Chef.

**UNIT - IV**

**Continuous Deployment and Cloud Integration:** Continuous deployment pipelines. Deployment strategies: Blue-Green and Canary deployment. Kubernetes architecture: Pods, Services and Deployments. Container orchestration. DevOps in cloud platforms: AWS, Microsoft Azure and Google Cloud. Infrastructure automation and scaling.

**UNIT - V**

**DevSecOps and Monitoring:** DevSecOps concepts and security in CI/CD pipelines, Vulnerability scanning tools. Microservices architecture, Monitoring and logging tools such as Prometheus, Grafana and ELK Stack, Site Reliability Engineering (SRE), DevOps metrics and performance monitoring, Industry case studies.

## TEXT BOOKS:


1. L. Bass, I. Weber, and L. Zhu, "DevOps: A Software Architect's Perspective," 2nd Edition, Addison-Wesley, Pearson Publication, 2015.
2. M. Krief, "Learning DevOps: A Comprehensive Guide to Accelerating DevOps Culture Adoption with Terraform, Azure DevOps, Kubernetes, and Jenkins", 2nd Edition, Packt Publishing, 2022.


## SUGGESTED READING:


1. R. Russell and J. Southgate, "Mastering Puppet 5: Optimize Enterprise-Grade Environment Performance with Puppet", 1st Edition, Packet Publishing, 2018.
2. J. Verona, "Practical DevOps," 2nd Edition, Packet Publishing, 2018.
3. G. Kim, J. Humble, P. Debois, and J. Willis, "The DevOps Handbook: How to Create World-Class Agility, Reliability, and Security in Technology Organizations", 1st Edition, IT Revolution Press, 2016.


## ONLINE RESOURCES:

1. https://nptel.ac.in/courses/128106012
2. https://www.coursera.org/courses?query=devops

**26CSE120**

## WEB INTELLIGENCE
**(Professional Elective-III)**

| | |
|---|---|
| Instruction | 3 L Hours per Week |
| Duration of Semester End Examination | 3 Hours |
| Semester End Examination | 60 Marks |
| Continuous Internal Evaluation | 40 Marks |
| Credits | 3 |

**PREREQUISITE:** Web Mining, Semantic Web.

**COURSE OBJECTIVES:** This course aims to
1. Understand the fundamentals of Web Intelligence and its components
2. Explore semantic web technologies and knowledge representation
3. Design intelligent web-based applications.

**COURSE OUTCOMES:** After the completion of this course, the student will be able to:
1. Understand and explain concepts of Web Intelligence, web data, and information retrieval techniques.
2. Apply semantic web technologies (RDF, OWL) for knowledge representation and reasoning.
3. Evaluate web structure using graph-based algorithms such as PageRank and HITS.
4. Design and develop intelligent web applications like recommendation systems and web analytics solutions.
5. Develop Semantic web applications and web based networks.

**CO-PO Articulation Matrix**

| PO / CO | PO 1 | PO 2 | PO 3 | PO 4 |
|---|---|---|---|---|
| **CO 1** | 2 | 1 | 2 | 1 |
| **CO 2** | 2 | 2 | 2 | 1 |
| **CO 3** | 2 | 2 | 2 | 1 |
| **CO 4** | 3 | 2 | 2 | 1 |
| **CO 5** | 3 | 2 | 2 | 1 |

1-Slightly, 2-Moderately, 3-Substantially

**UNIT-I**

**Introduction to Web Intelligence:** Ingredients of Web Intelligence, Topics of Web Intelligence. Information Retrieval - Document Representation, Retrieval Models, Evaluation of Retrieval Performance.

**UNIT-II**

**Semantic Web:** The Layered-Language Model, Metadata and Ontologies, Ontology Languages for the Web.

**Web Usage Mining**: Web-Log Processing, Analyzing Web Logs, Applications of Web Usage Mining, Clustering of Web Users, Classification Modelling of Web Users, Association Mining of Web Usages, Sequence-Pattern Analysis of Web Logs.

**UNIT-III**

**Web Content Mining:** Web Crawlers, Search Engines, Personalization of Web Content. Web Structure Mining- Modelling Web Topology, PageRank Algorithm, Hyperlink-Induced Topic Search (HITS) Random Walks on the Web, Social Networks & Graphs.

**UNIT-IV**

**Web Analytics and Applications:** Web analytics concepts, Traffic analysis and KPIs, Personalization and recommendation systems, Opinion mining and sentiment analysis, Web security and privacy issues, Building intelligent applications using APIs, Applications: e-commerce, social media, digital marketing.

**UNIT-V**

**Social Web and Applications:** Social Network Analysis, Blogs, Online communities, Web-based networks, Semantic Web applications: Semantic search, E-learning, Web services, Building intelligent web applications.

## TEXT BOOKS:


1. GautamShroff, "The Intelligent Web: Search, Smart Algorithms, and Big Data", 1st Edition, Oxford Press, 2019.
2. Akerkar, R. & Lingras, P., "Building an Intelligent Web: Theory and Practice", 1st Edition, Jones and Bartlett Publishers, Sudbury, Massachusetts, 2008.


## SUGGESTED READING:


1. Marmanis & Babenko, "Algorithms of the Intelligent Web", 1st Edition, Manning Publications, 2009.
2. Manning, Raghavan and Schuetze, "Introduction to Information Retrieval", 1st Edition, Cambridge University Press, 2008.
3. Douglas G. McIlwraith, Haralambos Marmanis, and Dmitry Babenko, "Algorithms of the Intelligent Web", 2nd Edition, Manning Publications, 2016


## ONLINE RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc24_cs65/
2. https://onlinecourses.nptel.ac.in/noc22_mg68/

**26CSC109**

## CYBER SECURITY LAB

| | |
|---|---|
| Instruction | 2 P Hours per Week |
| Duration of Semester End Examination | - |
| Semester End Examination | - |
| Continuous Internal Evaluation | 50 Marks |
| Credits | 1 |

**PREREQUISITE:** Network Security.

**COURSE OBJECTIVES:** This course aims to
1. Understand fundamental cyber security concepts, threats, and ethical practices.
2. Develop practical skills in using security tools to identify, analyse, and prevent cyber-attacks.

**COURSE OUTCOMES:** After completion of this course, students will be able to
1. Understand basic cyber security concepts, tools, and ethical hacking principles.
2. Perform vulnerability assessment and basic penetration testing using security tools.
3. Implement object recognition methods.
4. Analyze different types of cyber-attacks such as phishing, malware, and social engineering.
5. Implement security mechanisms like encryption, authentication, and network security controls.

**CO-PO Articulation Matrix**

| PO / CO | PO 1 | PO 2 | PO 3 | PO 4 |
|---|---|---|---|---|
| **CO 1** | 3 | 3 | - | 2 |
| **CO 2** | 2 | - | 3 | 2 |
| **CO 3** | 2 | 3 | - | 2 |
| **CO 4** | 2 | - | 3 | 2 |
| **CO 5** | - | 3 | - | 3 |

1-Slightly, 2-Moderately, 3-Substantially

## LIST OF EXPERIMENTS:
1. Identify different types of cybercrimes (phishing, hacking, identity theft, etc.)
2. Study CIA Triad (Confidentiality, Integrity, Availability), Analyze vulnerabilities in a sample system.
3. Social Engineering Simulation: Create a mock phishing email, Analyze user behaviour and awareness.
4. Proxy and Anonymization: Configure proxy using tools like Tor Browser Analyze IP masking.
5. Malware Analysis Basics: Study behavior of virus, worm, Trojan (in sandbox), Use tools like VirusTotal.
6. SQL Injection:Tool: DVWA (Damn Vulnerable Web App), Perform SQL injection attacks.
7. Cross-Site Scripting (XSS): Inject scripts into vulnerable web pages, Analyze impact.
8. Case Study on Cyber Laws: Analyze real cybercrime legal cases in India, Map to IT Act sections.
9. Email Forensics: Analyze email headers, Identify sender IP and spoofing.
10. Network Forensics: Tool: Wireshark, Capture and analyze packets.

## TEXT BOOKS:

1. Sunit Belpre and Nina Godbole, "Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives", 1st Edition, Wiley India Pvt.Ltd, 2011.
2. Malcolm McDonald "Web Security for Developers", 1st Edition, No Starch Press, June 2020.


## SUGGESTED READING:

1. Daniel G. Graham "Ethical Hacking: A Hands-on Introduction to Breaking in", 1st Edition, No Starch Press, 2021

2. Kevin Mandia, Chris Prosise, “Incident Response and Computer Forensics”, 1st Edition, Tata McGraw Hill, 2006.
3. Alfred Basta, Nadine Basta, Mary Brown, Ravinder Kumar, “Cyber Security and Cyber Laws”, 1st Edition, Paperback – 2018

**ONLINE RESOURCES:**

1. https://onlinecourses.swayam2.ac.in/nou19_cs08/preview
2. https://onlinecourses.swayam2.ac.in/cec20_cs15Francesco/preview

**26CSC110**

## NATURAL LANGUAGE PROCESSING LAB

| | |
|---|---|
| Instruction | 3 P Hours per Week |
| Duration of Semester End Examination | - |
| Semester End Examination | - |
| Continuous Internal Evaluation | 50 Marks |
| Credits | 1.5 |

## PREREQUISITE:

**COURSE OBJECTIVES:** This course aims to

1. Develop proficiency in designing and implementing end-to-end NLP pipelines using tools such as NLTK and spaCy.
2. Build competence in applying machine learning and deep learning techniques for text analytics using Scikit-learn and TensorFlow.
3. Enable the development of advanced NLP applications using transformer models like BERT with Hugging Face Transformers.

**COURSE OUTCOMES:** After completion of the course, students will be able to

1. Design and implement end-to-end NLP pipelines integrating preprocessing, feature engineering, modeling, and evaluation using tools such as NLTK and spaCy.
2. Apply and evaluate text representation techniques and classical machine learning models using Scikit-learn for effective text analytics.
3. Develop and assess deep learning-based NLP models using frameworks like TensorFlow and Keras.
4. Utilize word embedding techniques with Gensim to model semantic relationships in textual data.
5. Implement transformer-based NLP applications using BERT and Hugging Face Transformers for advanced tasks such as classification, question answering, and conversational.

**CO-PO Articulation Matrix:**

| PO / CO | PO 1 | PO 2 | PO 3 | PO 4 |
|---|---|---|---|---|
| **CO 1** | 3 | - | 3 | 2 |
| **CO 2** | 3 | - | 3 | - |
| **CO 3** | 3 | 2 | 3 | 2 |
| **CO 4** | 2 | 2 | - | 2 |
| **CO 5** | 3 | - | 2 | 2 |

1-Slightly, 2-Moderately, 3-Substantially

**LAB EXPERIMENTS:**

1. Design a complete NLP pipeline covering problem definition, data collection, preprocessing, feature extraction, modeling, and evaluation using NLTK, spaCy, and Scikit-learn.
2. Compare NLP libraries NLTK, spaCy, and TextBlob based on tokenization, tagging, and performance.
3. Implement preprocessing techniques: tokenization, stop-word removal, stemming, and lemmatization, and analyze their impact.
4. Perform advanced NLP tasks like POS tagging, NER, and dependency parsing using spaCy.
5. Implement text representations: Bag of Words, TF-IDF, and N-grams using Scikit-learn.
6. Build a text classification model using ML algorithms and evaluate with accuracy, precision, recall, and F1-score.
7. Implement neural models (Perceptron, Feedforward NN) using TensorFlow or PyTorch.
8. Train and analyze word embeddings (Word2Vec, GloVe) using Gensim.
9. Develop deep learning models (RNN, LSTM, GRU) for text classification using Keras.

10. Build transformer-based NLP applications (chatbot, QA) using BERT and Hugging Face Transformers.

## TEXT BOOKS:


1. Daniel Jurafsky and James H. Martin, "Speech and Language Processing", 3rd Edition, Pearson Publisher, 2021.
2. Steven Bird, Ewan Klein, Edward Loper, "Natural Language Processing with Python", 1st Edition, O'Reilly Media, 2009.


## SUGGESTED READING:


1. Yoav Goldberg, "Neural Network Methods in Natural Language Processing", 1st Edition, Morgan & Claypool Publishers, 2017.
2. Christopher Manning, "Foundations of Statistical Natural Language Processing", 1st Edition, MIT Press, 1999.
3. James Allen, "Natural Language Understanding", 2nd Edition, Pearson, 1995.


## ONLINE RESOURCES:

1. Stanford NLP Group – https://nlp.stanford.edu
2. Hugging Face Transformers Documentation – https://huggingface.co/docs
3. Kaggle – NLP datasets and notebooks

**26CSE121**

## GENERATIVE AI LAB
**(Professional Elective-III Lab)**

| | |
|---|---|
| Instruction | 3 P Hours per Week |
| Duration of Semester End Examination | - |
| Semester End Examination | - |
| Continuous Internal Evaluation | 50 Marks |
| Credits | 1.5 |

**PREREQUISITE**: Knowledge on Elements of Electrical Engineering.

**COURSE OBJECTIVES:** This course aims to
1. Understand the fundamental concepts of Artificial Intelligence, Machine Learning, Deep Learning, and the mathematical foundations of generative models.
2. Analyze and implement advanced neural architectures such as VAEs, GANs, RNNs/LSTMs, and Transformer models for generative tasks.
3. Explore Large Language Models (LLMs) like GPT and BERT, and apply prompt engineering and fine-tuning techniques for real-world applications.
4. Design and develop multi-agent systems for collaborative generative tasks using modern frameworks and tools.
5. Build end-to-end Generative AI applications using frameworks like LangChain, RAG systems, and multimodal models while addressing ethical and societal implications.

**COURSE OUTCOMES:** After the completion of this course, the student will be able to
1. Illustrate the evolution of Artificial Intelligence and differentiate between AI, Machine Learning, Deep Learning, and Generative AI in real-world applications.
2. Implement and analyze generative models such as VAEs, GANs, RNNs/LSTMs, and Transformer architectures for solving complex problems.
3. Apply Large Language Models (LLMs) including GPT and BERT for NLP tasks using prompt engineering and fine-tuning techniques.
4. Design and develop multi-agent systems for collaborative generative AI applications using modern frameworks.
5. Develop end-to-end generative AI solutions using LangChain, RAG, embeddings, and vector databases while evaluating ethical and societal implications.

**CO-PO Articulation Matrix**

| PO / CO | PO 1 | PO 2 | PO 3 | PO 4 |
|---|---|---|---|---|
| **CO 1** | 2 | 2 | 1 | - |
| **CO 2** | 3 | 2 | 2 | - |
| **CO 3** | 3 | 2 | 2 | 1 |
| **CO 4** | 3 | 3 | 2 | - |
| **CO 5** | 3 | 3 | 2 | 2 |

1-Slightly, 2-Moderately, 3-Substantially

## LIST OF EXPERIMENTS:
1. Design and implement an Artificial Neural Network (ANN) using TensorFlow/PyTorch to classify the MNIST dataset. Compare the performance by varying the number of hidden layers.
2. Perform transfer learning using a pre-trained model (ResNet/MobileNet) on a custom image dataset. Analyze the effect of freezing and unfreezing layers on model accuracy.
3. Implement a Variational Autoencoder (VAE) for image reconstruction using the MNIST dataset. Visualize the latent space and generate new samples.
4. Build and train a Generative Adversarial Network (GAN) to generate handwritten digit images. Plot generator and discriminator losses and display generated outputs.

5. Implement the scaled dot-product attention mechanism from scratch. Compute attention weights and visualize them using a heatmap.
6. Use a GPT-based model to generate text for a given task. Experiment with different prompts and analyze how prompt design affects the output.
7. Fine-tune a BERT model for sentiment analysis on a given dataset. Evaluate performance using accuracy, precision, and recall.
8. Design and evaluate prompt engineering techniques for tasks such as summarization, translation, and creative writing. Compare outputs using evaluation metrics or human judgment.
9. Develop a multi-agent system using AutoGen or CrewAI consisting of multiple agents (e.g., researcher and writer) to collaboratively generate a report on a given topic.
10. Implement a GAN-based application to generate synthetic images. Evaluate the quality of generated images using suitable metrics or visual inspection.
11. Develop a Retrieval-Augmented Generation (RAG) system using LangChain with embeddings and a vector database. Evaluate the relevance of responses for user queries.

**TEXT BOOKS:**


1. Altaf Rehmani, "Generative AI for Everyone: Understanding the Essentials and Applications of This Breakthrough Technology", 1st Edition, Pearson, 2024.
2. Charu C. Aggarwal, "Neural Networks and Deep Learning: A Textbook", 1st Edition, Springer, 2018.


**SUGGESTED READING:**


1. Josh Kalin, "Generative Adversarial Networks Cookbook", 1st Edition, Packt Publishing, 2018
2. Jesse Sprinter, "Generative AI in Software Development: Beyond the Limitations of Traditional Coding", Amazon Digital Services LLC - Kdp, 2024.


**ONLINE RESOURCES:**

1. nptel.ac.in/courses/106108703
2. https://onlinecourses.swayam2.ac.in/e-learning/preview/nou25_ma05

**26CSE122**

## INTERNET OF THINGS LAB
**(Professional Elective-III Lab)**

| | |
|---|---|
| Instruction | 3 P Hours per Week |
| Duration of Semester End Examination | - |
| Semester End Examination | - |
| Continuous Internal Evaluation | 50 Marks |
| Credits | 1.5 |

**PREREQUISITE**: Computer Architecture and Micro Processor, Programming for Problem Solving.

**COURSE OBJECTIVES:** This course aims to
1. Understand the individual components of IoT.
2. Impart necessary and practical knowledge in Internet of Things.
3. Develop skills required to build real-time IIoT based projects

**COURSE OUTCOMES:** after the completion of this course, the student will be able to
1. Understand Internet of Things and IIOT basics components.
2. Illustrate working of I/O devices, sensors & communication module.
3. Analyse the use of protocols in IoT.
4. Interface I/O devices, Sensors and communication module.
5. Develop real time IoT based projects.

**CO-PO Articulation Matrix**

| PO / CO | PO 1 | PO 2 | PO 3 | PO 4 |
|---|---|---|---|---|
| **CO 1** | - | - | 1 | 1 |
| **CO 2** | 1 | - | 1 | 1 |
| **CO 3** | 1 | - | 1 | 1 |
| **CO 4** | 1 | - | 2 | 2 |
| **CO 5** | 3 | - | 3 | 3 |

1-Slightly, 2-Moderately, 3-Substantially

**EXPERIMENTS:**
1. Introduction to IoT equipments and perform necessary software installation.
2. Write a program to interface LED/Buzzer with Raspberry Pi and to turn ON LED for 1sec after every 2 seconds.
3. Interface Bluetooth with Raspberry Pi and write a program to send sensor data to smart phone using Bluetooth.
4. Write a program to interface flame/smoke sensor with Raspberry Pi and give an alert message when flame/smoke is detected.
5. Write a program to interface Camera sensor with Raspberry Pi and capture the images and do analysis.
6. Design and Develop a system to identify accident and send alert messages.
7. Design and develop Home Automation System.
8. Design and develop IoT based Fire Altering System to give an alert message to fire department.
9. Implementation of Smart Agriculture Monitoring System.
10. Implementation of Traffic Light System based on density.

**TEXT BOOKS:**

1. Arsheep Bahga, Vijay Madisetti, “Internet of Things: A Hands-On Approach”, 1st Edition, Universities Press, Reprint 2020.
2. Raj Kamal, Internet of Things, Architecture and Design Principles, 1st Edition, McGraw Hill Education, Reprint 2018.

## SUGGESTED READING:


1. Pethuru Raj, Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", 1st Edition, CRC Press, 2022.
2. Perry Lea, Internet of Things for Architects: "Architecting IoT solutions by implementing sensors, communication infrastructure, edge computing, analytics, and security", 1st Edition, Packt Publications, Reprint 2018.
3. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, "IoT Fundamentals Networking Technologies, Protocols, and Use Cases for the Internet of Things", 1st Edition, CISCO Press, 2017.


## ONLINE RESOURCES:

1. https://owasp.org/www-project-internet-of-things/
2. NPTEL: Sudip Misra, IIT Khargpur, Introduction to IoT: Part-1, https://nptel.ac.in/courses/106/105/106105166/
3. https://www.coursera.org/in/articles/internet-of-things

**26CSE123**

## ARTIFICIAL INTELLIGENCE FOR ROBOTICS LAB
**(Professional Elective-III Lab)**

| | |
|---|---|
| Instruction | 3 P Hours per week |
| Duration of Semester End Examination | - |
| Semester End Examination | - |
| Continuous Internal Evaluation | 50 Marks |
| Credits | 1.5 |

**PREREQUISITES:** Artificial intelligence, IoT.

**COURSE OBJECTIVES:** This course aims to
1. Build real-world Artificial Intelligence applications with Python.
2. To program the robots to intelligently interact with the world around you.

**COURSE OUTCOMES:** After the completion of this course, the student will be able to
1. Identify the key issues robot programming.
2. Develop problem solving and critical thinking skills to build AI enabled robots.
3. Implement object recognition methods.
4. Implement toy pick-up robot and voice command response robot.
5. Analyze the human emotion-model.

**CO-PO Articulation Matrix**

| PO / CO | PO 1 | PO 2 | PO 3 | PO 4 |
|---|---|---|---|---|
| **CO 1** | - | 3 | - | - |
| **CO 2** | - | - | 3 | 2 |
| **CO 3** | - | 3 | - | 2 |
| **CO 4** | - | - | 3 | 2 |
| **CO 5** | - | 3 | - | 3 |

1-Slightly, 2-Moderately, 3-Substantially

**LIST OF EXPERIMENTS:**
1. Installation and configuration of Linux, Robotic Operating System (ROS), Raspberry Pi 3, Arduino, Python 2.7 or 3.5, with NumPy, SciPy, Matplotlib, and scikit
2. Creating the Ubuntu Linux virtual machine under Virtual Box.
3. Assemble the robot from the components available.
4. Object Recognition Using Neural Networks and Supervised Learning: create a CNN to examine images. Train the network on two sets of images one containing toys and one without toys. Ttrain the network to get better than 90% accuracy in classifying images as either having toys, or not having toys. Teste the network to verify its output.
5. Program the robot to Pick up the toys and place them in the toys box.
6. Teaching a robot to listen and respond, understand some commands.
7. Avoiding the staircase / objects
8. Giving the Robot an Artificial Personality through the Robot Emotion Engine Simulate personality: Have moods Have feeling Show empathy, Interact with people.
9. Adaptive Behavior and Learning Robot, Learns from user interactions, Adjusts its behavior over time, Improves responses based on feedback.
10. Autonomous Smart Robot with Integrated Navigation and Decision-Making.

**Mini Project:**
One real life large application to be implemented.

## TEXT BOOKS:


1. Francis X. Govers III, "Artificial Intelligence for Robotics", 1st Edition, Packt Publishing, 2024.
2. Gang Peng et al., Introduction to Intelligent Robot System Design: Application Development with ROS, Springer, 1st Edition, 2023.


## SUGGESTED READING:


1. Nikleia Eteokleous, Efi Nisforou, Designing, Constructing and Programming Robots for Learning, IGI Global, Publishing, 1st Edition, 2021.
2. Lentin Joseph and Jonathan Cacace, Mastering ROS 2 for Robotics Programming, Packt Publishing, 4th Edition, 2025.
3. Danny Staple, "Learn Robotics Programming", 2nd Edition, Packt Publishing, 2021.


## ONLINE RESOURCES:

1. https://roboticsindia.live/list-of-nptel-robotics-course-2022/
2. https://nptel.ac.in/courses/107106090

**26CSE124**

## DEVOPS TOOLS LAB
**(Professional Elective-III Lab)**

| | |
|---|---|
| Instruction | 3 P Hours per Week |
| Duration of Semester End Examination | - |
| Semester End Examination | - |
| Continuous Internal Evaluation | 50 Marks |
| Credits | 1.5 |

**PREREQUISITE**: Knowledge of Software Engineering, Operating Systems, Cloud Computing and Programming Concepts.

**COURSE OBJECTIVES:** This course aims to:
1. Enable students to design and manage collaborative software development workflows using DevOps practices and version control systems.
2. Develop the ability to implement automated CI/CD pipelines and container-based deployment using modern DevOps tools and orchestration platforms.
3. Equip students with skills in infrastructure automation, scalable system deployment, and end-to-end DevOps pipeline development using IaC and configuration management tools.

**COURSE OUTCOMES:** After the completion of this course, the student will be able to
1. Apply DevOps practices to design and manage collaborative software development workflows using version control systems like Git.
2. Design and implement automated CI/CD pipelines using Jenkins for continuous integration, testing, and deployment.)
3. Containerize applications and manage their lifecycle using Docker, including image creation, optimization, and runtime management.
4. Design and deploy scalable multi-container applications using Docker Compose and Kubernetes, ensuring reliability and fault tolerance
5. Implement Infrastructure as Code (IaC) and develop end-to-end automated DevOps pipelines using tools like Puppet for consistent and efficient system deployment.

**CO-PO Articulation Matrix**

| PO / CO | PO 1 | PO 2 | PO 3 | PO 4 |
|---|---|---|---|---|
| **CO 1** | 2 | 2 | 3 | 1 |
| **CO 2** | 3 | 2 | 3 | 2 |
| **CO 3** | 2 | 1 | 3 | 2 |
| **CO 4** | 3 | 1 | 3 | 3 |
| **CO 5** | 3 | 2 | 3 | 2 |

1-Slightly, 2-Moderately, 3-Substantially

**LIST OF EXPERIMENTS:**
1. Design and demonstrate a collaborative version control workflow using Git to manage source code efficiently in a multi-developer environment.
2. Design and implement a Continuous Integration (CI) pipeline using Jenkins to automate the build and testing process of an application.
3. Design and implement a distributed CI/CD system using Jenkins Master-Agent architecture to improve scalability and performance.
4. Design and implement a containerization solution for an application using Docker, and systematically manage and analyze the complete container lifecycle to ensure efficient deployment and execution.
5. Develop, containerize, and deploy a web application by creating a custom Docker image using a Dockerfile, ensuring portability, reproducibility, and optimized performance.

6. Design and implement the deployment of a containerized application on a Kubernetes cluster, and manage its lifecycle to ensure scalability, reliability, and fault tolerance.
7. Design and implement a multi-container application architecture using Docker Compose to manage and orchestrate interdependent services in a unified environment.
8. Design and implement an Infrastructure as Code (IaC) solution using Puppet in a pull-based architecture to automate system provisioning, configuration, and management across multiple nodes in a distributed environment.
9. Design and implement a modular and reusable Infrastructure as Code (IaC) solution using Puppet to automate the configuration and management of multiple nodes in a distributed environment. Simulate an end-to-end DevOps pipeline.
10. Design and implement virtualization infrastructure in a DevOps environment using virtual machines to demonstrate advanced concepts of environment provisioning, resource management, isolation, scalability, and deployment automation for enterprise-level applications.

## TEXT BOOKS:


1. L. Bass, I. Weber, and L. Zhu, "DevOps: A Software Architect's Perspective," 2nd Edition, Addison-Wesley, Pearson Publication, 2015.
2. M. Krief, "Learning DevOps: A Comprehensive Guide to Accelerating DevOps Culture Adoption with Terraform, Azure DevOps, Kubernetes, and Jenkins", 2nd Edition, Packt Publishing, 2022.


## SUGGESTED READING:


1. R. Russell and J. Southgate, "Mastering Puppet 5: Optimize Enterprise-Grade Environment Performance with Puppet", 1st Edition, Packet Publishing, 2018.
2. J. Verona, "Practical DevOps", 2nd Edition, Packet Publishing, 2018.
3. G. Kim, J. Humble, P. Debois, and J. Willis, "The DevOps Handbook: How to Create World-Class Agility, Reliability, and Security in Technology Organizations," 1st Edition, IT Revolution Press, 2016.


## ONLINE RESOURCES:

1. https://nptel.ac.in/courses/128106012
2. https://www.coursera.org/courses?query=devops

**26CSE125**

## WEB INTELLIGENCE LAB
**(Professional Elective-III Lab)**

| | |
|---|---|
| Instruction | 3 P Hours per Week |
| Duration of Semester End Examination | - |
| Semester End Examination | - |
| Continuous Internal Evaluation | 50 Marks |
| Credits | 1.5 |

**PREREQUISITE:** Web Mining, Semantic Web.

**COURSE OBJECTIVES:** This course aims to
1. Understand the fundamentals of Web Intelligence and its components.
2. Explore semantic web technologies and knowledge representation.
3. Design intelligent web-based applications.

**COURSE OUTCOMES:** After the completion of this course, the student will be able to
1. Understand the basic concepts of Web Intelligence applications.
2. Develop semantic web applications using RDF, OWL.
3. Evaluate web structure using graph-based algorithms such as PageRank and HITS.
4. Design and develop intelligent web applications like recommendation systems and web analytics solutions.
5. Develop Semantic search and web analytic applications.

**CO-PO Articulation Matrix**

| PO / CO | PO 1 | PO 2 | PO 3 | PO 4 |
|---|---|---|---|---|
| **CO 1** | 2 | 1 | 2 | 1 |
| **CO 2** | 3 | 2 | 2 | 1 |
| **CO 3** | 2 | 2 | 2 | 1 |
| **CO 4** | 3 | 2 | 2 | 1 |
| **CO 5** | 3 | 2 | 2 | 1 |

1-Slightly, 2-Moderately, 3-Substantially

## LIST OF EXPERIMENTS:
1. Explore the ingredients of Web Intelligence for developing intelligent applications.
2. Represent data using RDF triples using tools like Protégé / RDFLib.
3. Develop ontology for real-time applications using Protégé.
4. Analyze user behavior from logs with Web Usage Analysis.
5. Develop a topic-specific web crawler using keyword filtering.
6. Calculate hub and authority scores using HITS Algorithm.
7. Recommend content based on user preferences with Web Content Personalization.
8. Analyze website traffic data and Visualize KPIs with Web Analytics Dashboard.
9. Extract and analyze blog/forum data using Blog/Community Data Analysis.
10. Build a simple semantic search using ontology.

## TEXT BOOKS:

1. Gautam Shroff, "The Intelligent Web: Search, Smart Algorithms, and Big Data", 1st Edition, Oxford Press,2019
2. Akerkar, R. & Lingras, P., "Building an Intelligent Web: Theory and Practice", 1st Edition, Jones and Bartlett Publishers, Sudbury, Massachusetts, 2008.

## SUGGESTED READING:


1. Marmanis & Babenko, "Algorithms of the Intelligent Web", 1st Edition, Manning Publications, 2009.
2. Manning, Raghavan and Schuetze, "Introduction to Information Retrieval", 1st Edition, Cambridge University Press, 2008.
3. Douglas G. McIlwraith, Haralambos Marmanis, and Dmitry Babenko, "Algorithms of the Intelligent Web", 2nd Edition, Manning Publications, 2016.


## ONLINE RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc24_cs65/
2. https://onlinecourses.nptel.ac.in/noc22_mg68/

# III-Semester
# and
# IV-Semester
# Syllabus

**CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY**
**R26 (In line with AICTE Model Curriculum) with effect from AY 2026-27**

**M. Tech. (Computer Science and Engineering)**

**SEMESTER – III**

| S. No | Course Code | Title of the Course | Scheme of Instruction | | | Scheme of Examination | | | Credits |
|---|---|---|---|---|---|---|---|---|---|
| | | | Hours per Week | | | Duration of SEE in Hours | Maximum Marks | | |
| | | | L | T | P/D | | CIE | SEE | |
| **THEORY** | | | | | | | | | |
| 5. | 26CSExxx | Professional Elective – IV | 3 | - | - | 3 | 40 | 60 | 3 |
| 6. | 26CSExxx | Professional Elective – V | 3 | - | - | 3 | 40 | 60 | 3 |
| 7. | 26xxxxxx | Open Elective | 3 | - | - | 3 | 40 | 60 | 3 |
| **DISSERATATION** | | | | | | | | | |
| 8. | 26CSC111 | Dissertation Phase-I | - | - | 20 | - | 100 | - | 10 |
| **Total** | | | **9** | | **20** | **–** | **220** | **180** | **19** |

**L: Lecture** **D: Drawing** **CIE: Continuous Internal Evaluation**
**T: Tutorial** **P: Practical/Dissertation** **SEE-Semester End Examination**

| Professional Elective – IV | |
|---|---|
| 26CSE126 | Advanced Deep Learning |
| 26CSE127 | Parallel and High Performance Computing |
| 26CSE128 | Extended Reality |
| 26CSE129 | Software Quality and Testing |
| 26CSE130 | Blockchain Technology |

| Professional Elective-V | |
|---|---|
| 26CSE131 | Algorithmic Game Theory |
| 26CSE132 | Fog and Edge Computing |
| 26CSE133 | Quantum Computing |
| 26CSE134 | Social Network and Analytics |
| 26CSE135 | Digital Forensics |

| Open Elective | |
|---|---|
| 26CSO101 | Business Analytics |
| 26MEO101 | Industrial Safety |
| 26MEO103 | Composite Materials |
| 26MEO104 | Alternative Energy Sources |
| 26MEO105 | Computational Fluid Dynamics |
| 26CEO101 | Cost Management of Engineering Projects |
| 26EEO104 | Waste to Energy |
| 26PYO101 | History of Science and Technology |

****Students those who are going for Internship / Industrial project, may complete these courses through NPTEL/ MOOCs**

**26CSE126**

## ADVANCED DEEP LEARNING

**(Professional Elective – IV)**

| | |
|---|---|
| Instruction | 3 L Hours per Week |
| Duration of Semester End Examination | 3 Hours |
| Semester End Examination | 60 Marks |
| Continuous Internal Evaluation | 40 Marks |
| Credits | 3 |

**PREREQUISITE**: Deep Learning.

**COURSE OBJECTIVES:** This course aims to

1. Build a strong foundation in advanced neural network optimization, regularization, and architectural design for robust deep learning.
2. Develop expertise in modern vision, sequence, and graph-based architectures for solving complex real-world problems.
3. Explore cutting-edge paradigms like meta-learning and federated learning for data-scarce and privacy-sensitive applications.

**COURSE OUTCOMES:** After the completion of this course, the student will be able to

1. Analyze and apply advanced neural network components to design efficient and well-generalized deep learning models.
2. Evaluate and implement CNN architecture and Vision Transformers along with advanced attention mechanisms for scalable visual representation learning.
3. Design and compare deep learning pipelines with modern positional encodings.
4. Apply Graph Neural Networks and specialized deep learning models for structured data, time series forecasting, and medical image analysis.
5. Implement and critically assess advanced learning paradigms.

**CO-PO Articulation Matrix**

| PO / CO | PO 1 | PO 2 | PO 3 | PO 4 |
|---|---|---|---|---|
| **CO 1** | 3 | 1 | 3 | 2 |
| **CO 2** | 3 | 1 | 3 | 2 |
| **CO 3** | 3 | 2 | 3 | 2 |
| **CO 4** | 3 | 1 | 3 | 3 |
| **CO 5** | 3 | 2 | 3 | 3 |

1-Slightly, 2-Moderately, 3-Substantially

**UNIT-I**

**Foundations:** Universal approximation theorem, Weight Initialization Techniques- Xavier (Glorot) Initialization, He (Kaiming) Initialization, Orthogonal Initialization, and LSUV (Layer-Sequential Unit-Variance) Initialization.

**Advanced Optimization:** Activation functions -ReLU, GELU, Swish, Mish, AdamW, Layer-wise Adaptive Moments optimizer for Batch training (LAMB).

**Regularization:** DropBlock, Label Smoothing, Mixup, CutMix, R-Drop, Layer Norm, Instance Norm, Group Norm, RMS Norm.

**UNIT-II**

**Advanced CNNs**: EfficientNet, ConvNeXt, CNN design principles and scaling laws, Depthwise Separable Convolutions, Dilated Convolutions, Deformable Convolutions, and Neural Architecture Search (NAS).

**Advanced Attention architecture:**, Sparse Attention, Linear Attention, Flash Attention.

**Vision Transformers:** DeiT, BEiT, Swin Transformer, MAE (Masked Autoencoders), patch embedding, and pre-training methods.

**UNIT-III**

**Object Detection and Image Segmentation:** Faster R-CNN, DETR, and DINO,Mask R-CNN and Segment Anything Model (SAM)

**Sequence Models:** Bidirectional Recurrent Neural Networks (Bi-RNNs), gradient flow analysis and limitations, Beam Search, Coverage Mechanisms, Connectionist Temporal Classification (CTC) loss, and positional encoding variants including sinusoidal encoding, Rotary Position Embedding (RoPE), and Attention with Linear Biases (ALiBi).

**UNIT-IV**

**Graph Neural Networks (GNNs):** Graph Convolutional Networks (GCN), Graph Attention Networks (GAT), GraphSAGE, message passing frameworks, temporal Graph Neural Networks, Knowledge Graph Embeddings, Link Prediction, Graph Classification, and Molecular GNNs.

**Deep Learning for Time Series:** Temporal Convolutional Networks (TCN), Temporal Fusion Transformer, N-BEATS, and Chronos models.

**UNIT-V**

**Few-Shot Learning:** Prototypical Networks, Matching Networks, Relation Networks, Model-Agnostic Meta-Learning (MAML), Reptile, and hallucination-based data augmentation techniques.

**One-Shot Learning:** Siamese Networks, triplet loss, memory-augmented neural networks, one-shot face verification, and the Omniglot dataset.

**Federated Learning:** Federated Averaging (FedAvg), FedProx, personalized federated learning, differential privacy, split learning, communication-efficient federated learning, and heterogeneous data challenges.

## TEXT BOOKS:


1. Ian Goodfellow, Yoshua Bengio and Aaron Courville, "Deep Learning", 1st Edition, MIT Press, 2016.
2. Aston Zhang, Zachary C. Lipton, Mu Li and Alexander J. Smola, "Dive into Deep Learning (D2L)", 1st Edition, Cambridge University Press, 2023.


## SUGGESTED READING:


1. Christopher M. Bishop and Hugh Bishop, "Deep Learning: Foundations and Concepts", 1st Edition, Springer, 2024.
2. Simon J.D. Prince, "Understanding Deep Learning", 1st Edition, MIT Press, 2024.
3. Qiang Yang, Lixin Fan, and Han Yu, Federated Learning, 1st Edition, Springer Nature Singapore Pvt. Ltd., 2020.


## ONLINE RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc24_cs89/preview Deep Learning for Computer Vision, Prof. Vineeth N Balasubramanian, IIT Hyderabad (NPTEL)
2. http://introtodeeplearning.com MIT 6.S191: Introduction to Deep Learning (Alexander Amini & Ava Amini, MIT)
3. https://www.youtube.com/playlist?list=PLoROMvodv4rNRRGdS0rBbXOUGA0wjdh1X Stanford CS230: Deep Learning (Andrew Ng, Stanford, YouTube)
4. https://www.youtube.com/playlist?list=PLoROMvodv4rMC6zfYmnD7UG3LVvwaITY5 Stanford CS330: Deep Multi-Task and Meta-Learning (Chelsea Finn, Stanford, YouTube) [Covers Few-Shot, Zero-Shot]

**26CSE127**

## PARALLEL AND HIGH PERFORMANCE COMPUTING
**(Professional Elective – IV)**

| | |
|---|---|
| Instruction | 3 L Hours per Week |
| Duration of Semester End Examination | 3 Hours |
| Semester End Examination | 60 Marks |
| Continuous Internal Evaluation | 40 Marks |
| Credits | 3 |

**PREREQUISITE**: Computer Organization, Operating Systems.

**COURSE OBJECTIVES:** This course aims to
1. Understand the concepts of Parallelism, computing environments and HPC ecosystems.
2. Learn various parallel algorithms and strategies
3. Study parallel languages and HPC ecosystems

**COURSE OUTCOMES:** After the completion of this course, the student will be able to
1. Understand the concepts various levels of parallelisms, GPU programming models and, HPC ecosystems.
2. Identify the performance limits and profiling of computer programs
3. Analyse the complexities of parallel algorithms.
4. Develop parallel applications using OpenMP.
5. List tools and resources for better coding

**CO-PO Articulation Matrix**

| PO / CO | PO 1 | PO 2 | PO 3 | PO 4 |
|---|---|---|---|---|
| **CO 1** | 2 | - | 1 | 2 |
| **CO 2** | 2 | 1 | 1 | 2 |
| **CO 3** | 2 | 3 | 2 | 1 |
| **CO 4** | 3 | 2 | 2 | 2 |
| **CO 5** | 2 | 2 | 3 | 2 |

1-Slightly, 2-Moderately, 3-Substantially

**UNIT- I**

**Parallel Computing:** Introduction, need and benefits of parallel computing, Fundamental laws of parallel computing, working of parallel computing, Hardware Model for heterogeneous parallel systems, application/software model, Parallel Approaches and strategies, Parallel vs comparative speedups.

**UNIT-II**

**Parallel Program Development and Algorithms:** Parallel program development cycle, performance limits and profiling. Parallel Algorithms analysis, complexity, Spatial Hashing, Prefix sum pattern and its importance in parallel computing.

**UNIT-III**

**CPU for Parallel Computing:** Vectorization- vectorization and SIMD, vectorization methods, compiler flags for vectorization, Multi-core and Threading- OpenMP, Distributed Memory- MPI examples.

**UNIT-IV**

**GPUs:** GPU architecture and benefits, Programming models for GPUs, OpenACC and OpenMP, GPU languages, profiling tools.

**UNIT-V**

**High Performance Computing Ecosystems:** Affinity, File operations for parallel world: components of a high- performance filesystem, standard file operations, HDF5, Overview of tools and resources for better code.

## TEXT BOOKS:


1. Robert Robe, Yuliana Zamora, "Parallel and High Performance Computing", 1st Edition, Manning Publications, 2021
2. Charles Severance, Kevin Dowd, "High Performance Computing", 1st Edition, OpenStax CNX, 2021.


## SUGGESTED READINGS:


1. Peter Pacheco, "Introduction to Parallel Programming", 1st Edition, Morgan Kaufmann Publishers, 2011.
2. Michael J. Quinn, "Parallel programming in C with MPI and OpenMP", 1st Edition, McGraw-Hill Higher Education, 2004.
3. William Gropp, "Using MPI: portable parallel programming with the message-passing interface", 2nd Edition, M I T press, 1999.


## ONLINE RESOURCES:

1. https://archive.org/details/cnx-org-col11136/page/n57/mode/2up

**26CSE128**

## EXTENDED REALITY
**(Professional Elective – IV)**

| | |
|---|---|
| Instruction | 3 L Hours per Week |
| Duration of Semester End Examination | 3 Hours |
| Semester End Examination | 60 Marks |
| Continuous Internal Evaluation | 40 Marks |
| Credits | 3 |

**PREREQUISITE**: Basic knowledge in Computer Graphics, Programming.

**COURSE OBJECTIVES:** This course aims to
1. Introduce the fundamental concepts, history, and evolution of Extended Reality (XR) technologies.
2. Analyze different XR technologies, interfaces, methodologies, and their real-world applications.
3. Explore the applications of XR technologies in aviation, healthcare, and education sectors.

**COURSE OUTCOMES:** After the completion of this course, the student will be able to
1. Fundamentals, history, hardware, software, and applications of Extended Reality technologies.
2. Differentiate between Augmented Reality, Virtual Reality, and Mixed Reality along with their characteristics, interfaces, and implementation methodologies.
3. Apply XR technologies in aviation-related training, maintenance, and operational support systems.
4. Analyze the role of AR/VR/MR technologies in healthcare applications such as medical imaging, radiology, and surgical planning.
5. Evaluate the impact of Augmented and Mixed Reality technologies in enhancing teaching-learning processes in the education sector

**CO-PO Articulation Matrix**

| PO / CO | PO 1 | PO 2 | PO 3 | PO 4 |
|---|---|---|---|---|
| **CO 1** | 2 | - | - | - |
| **CO 2** | 2 | 2 | 1 | 2 |
| **CO 3** | 3 | 1 | - | 1 |
| **CO 4** | 1 | - | - | - |
| **CO 5** | 2 | 1 | 1 | 1 |

**UNIT – I**

**Introduction to Extended Reality:** Introduction, History of XR, Hardware Parameters for Extended Reality, Software Used for XR Systems, Applications of XR.

**UNIT – II**

**Characteristics, Benefits, and an Explicative Insight on Extended Reality (XR):** Augmented Reality , Virtual Reality, Mixed Reality, AR Hardware, AR Hardware and Software, AR Types, Types of Different AR Interfaces, Methodologies for Combining Real Images and Virtual Objects, VR Hardware and Software, Types of VR.

**UNIT – III**

**Applications of Extended Reality Technologies in Aviation Sector**: Application of AR for Training of Aircraft Maintenance and Operations Support, Application of AR in Aircraft, Maintenance, Application of AR for Maintenance Operations and Providing Complex Training in Aeronautic-Related Processes.

**UNIT – IV**

**Applications of Mixed Reality in Healthcare:** Role of Augmented Reality and Virtual Reality in Medical Imaging, Role of Virtual Reality/Augmented Reality in Radiology, Surgical Preplanning and

Medical Image Analysis, Virtual Reality Visualization of Segmented Radiological Images, Virtual Reality Visualization of Un Segmented Radiological Images.

**UNIT – V**

**Augmented and Mixed Reality in Education Sector:** Integrating Augmented Reality Technology to Enhance Children's Learning in Marine Education, Benefits of Augmented Reality in Education Sector, Mixed Reality in Education Sector.

## TEXT BOOKS:


1. Manisha Vohra, "Introduction to Extended Reality (XR) Technologies", John Wiley & Sons Scrivener Publishing, 1st edition, 2025
2. Dieter Schmalstieg, Tobias Höllerer, "Augmented Reality: Principles and Practice", Addison-Wesley Professional, 1st edition, 2016.


## SUGGESTED READING:


1. Alan B. Craig, "Understanding Augmented Reality", Morgan Kaufmann, 1st edition, 2013.
2. Alan B. Craig, William R. Sherman, Jeffrey D. Will, "Developing Virtual Reality Applications", Morgan Kaufmann, 1st edition, 2009

**26CSE129**

## SOFTWARE QUALITY AND TESTING

**(Professional Elective – IV)**

| | |
|---|---|
| Instruction | 3 L Hours per Week |
| Duration of Semester End Examination | 3 Hours |
| Semester End Examination | 60 Marks |
| Continuous Internal Evaluation | 40 Marks |
| Credits | 3 |

**PREREQUISITE**: Object-Oriented Programming and Software Engineering.

**COURSE OBJECTIVES:** This course aims to

1. Understand the basic concepts, standards, metrics, and challenges of Software Quality Assurance and Software Testing.
2. Analyse software quality management techniques, testing methods, testing tools, and quality assurance processes used in software development.
3. Apply software testing strategies, automated testing tools, and quality assurance practices to develop reliable and high-quality software systems..

**COURSE OUTCOMES:** After the completion of this course, the student will be able to

1. Understand software quality factors, quality assurance components, and quality plans.
2. Analyse quality assurance activities, configuration management, documentation control, and project monitoring methods.
3. Analyse software quality metrics, standards, and process improvement models
4. Apply software testing strategies, testing methods, and testing processes for software verification.
5. Develop and evaluate software testing solutions using automated testing tools for different software applications.

**CO-PO Articulation Matrix**

| PO / CO | PO 1 | PO 2 | PO 3 | PO 4 |
|---|---|---|---|---|
| **CO 1** | 2 | 1 | 3 | 1 |
| **CO 2** | 3 | 2 | 3 | 2 |
| **CO 3** | 3 | 2 | 3 | 2 |
| **CO 4** | 3 | 2 | 3 | 3 |
| **CO 5** | 3 | 3 | 3 | 3 |

1-Slightly, 2-Moderately, 3-Substantially

**UNIT - I**

**Fundamentals of Software Quality Assurance:** The Software Quality Challenge, Introduction Software Quality Factors, the Components of the Software Quality Assurance System – Overview, Development and Quality Plans.

**UNIT - II**

**Quality Management in Software Projects:** Integrating Quality Activities in the Project Life Cycle, Assuring the Quality of Software Maintenance Components, CASE Tools and their effect on Software Quality, Procedure and Work Instructions, Supporting Quality Devices, Configuration Management, Documentation Control, Project Progress Control.

**UNIT - III**

**Software Quality Standards and Metrics:** Software Quality Metrics, Costs of Software Quality, Quality Management Standards - ISO 9000 and Companion ISO Standards, Capability Maturity Model (CMM), Capability Maturity Model Integration (CMMI), People Capability Maturity Model (PCMM),

Malcolm Baldrige, 3 Sigma, 6 Sigma, SQA Project Process Standards – IEEE Software Engineering Standards

**UNIT - IV**

**Software Testing Process and Strategies:** Building a Software Testing Strategy, Establishing a Software Testing Methodology, Determining Your Software Testing Techniques, Eleven – Step Software Testing Process Overview, Assess Project Management Development Estimate and Status, Develop Test Plan, Requirements Phase Testing, Design Phase Testing, Program Phase Testing, Execute Test and Record Results, Acceptance Test, Report Test Results, Test Software Changes, Evaluate Test Effectiveness.

**UNIT - V**

Testing Client / Server Systems, Testing the Adequacy of System Documentation, Testing Web-based Systems, Testing Off – the – Shelf Software, Testing in a Multiplatform Environment, Testing Security, Testing a Data Warehouse, Creating Test Documentation, Software Testing Tools, Taxonomy of Testing Tools, Methodology to Evaluate Automated Testing Tools, Load Runner, Win Runner and Rational Testing Tools, Java Testing Tools, Java Metrics Analyzer (JMetra), Java Unit Testing Framework (JUNIT) and Cactus.

## TEXT BOOKS:


1. Stephen H. Kan, "Metrics and Models in software Quality Engineering", 2nd Edition, Addison-Wesley Professional, 2003
2. Aditya P. Mathur, "Foundations of Software Testing", 1st Edition, Pearson Education India, 2008.


## SUGGESTED READING:


1. Claude Y. Laporte and Alain April, "Software Quality Assurance", 1st Edition, Wiley-IEEE Computer Society Press, 2018
2. William E. Perry, "Software Testing", 3rd Edition, Wiley India / John Wiley & Sons, 2006
3. K. V. K. K. Prasad, "Software Testing Tools", Revised Edition, Dreamtech Press / Wiley Dreamtech Publisher, 2012


## ONLINE RESOURCES:

1. https://nptel.ac.in/courses/106105150
2. https://www.coursera.org/professional-certificates/software-qa-test-automation-engineering

**26CSE130**

## BLOCKCHAIN TECHNOLOGY

**(Professional Elective – IV)**

| | |
|---|---|
| Instruction | 3 L Hours per Week |
| Duration of Semester End Examination | 3 Hours |
| Semester End Examination | 60 Marks |
| Continuous Internal Evaluation | 40 Marks |
| Credits | 3 |

**PREREQUISITE**: Distributed Systems, Computer Networks.

**COURSE OBJECTIVES:** This course aims to

1. Introduce the fundamental design and architectural primitives of Blockchain and consensus protocols.
2. Explore various Blockchain platforms.
3. Understand and develop smart contracts and decentralized applications.
4. Understand the significance of Hyperledger Fabric and composer.
5. Apply Blockchain securely in various sectors ranging from Financial to Government.

**COURSE OUTCOMES:** After the completion of this course, the student will be able to

1. Understand the fundamental design and architectural primitives of Blockchain and consensus protocols.
2. Explore various Blockchain platforms and identify the significance of smart contracts.
3. Identify the working of Ethereum and decentralized applications.
4. Implement the Blockchain applications with Hyperledger Fabric and Composer.
5. Apply Blockchain in different application domains such as financial and supply chain sectors.

**CO-PO Articulation Matrix**

| PO / CO | PO 1 | PO 2 | PO 3 | PO 4 |
|---|---|---|---|---|
| **CO 1** | 3 | 3 | 3 | 3 |
| **CO 2** | 3 | 3 | 3 | 3 |
| **CO 3** | 3 | 3 | 3 | 3 |
| **CO 4** | 3 | 3 | 3 | 3 |
| **CO 5** | 3 | 3 | 3 | 3 |

1-Slightly, 2-Moderately, 3-Substantially

**UNIT-I**

**Introduction to Blockchain:** Basics, History, Need of Blockchain, Architecture, Blockchain components, MerkleTree, Transactions, Hash functions, digital signatures.

**Consensus Protocols:** Proof of Work (PoW), Proof of Stake (PoS), Permissioned Blockchain: RAFT Consensus, Byzantine General Problem, Practical Byzantine Fault Tolerance.

**UNIT-II**

**Introduction to Blockchain platforms:** Ethereum, Hyperledger, IBM Blockchain, BigChainDB, IPFS, Dapps.

**Introduction to smart contracts:** Basic description of smart contracts, history of smart contracts, smart contracts operations and management.

**UNIT-III**

**Ethereum Blockchain-**concepts and terminologies, Transaction and Block in Ethereum, Ethereum Client, Mist Wallet, Accounts, Ethereum Smart Contracts, Ethereum Virtual Machine (EVM), Byte Code interpretation, Ethereum mining reward scheme, gas pricing.

**Decentralized application development:** Introduction to DApps development, Native application development using Java (with RPC) verses JavaScript applications

**UNIT-IV**

**Hyperledger Fabric** – Blockchain for Enterprise, Overview, Transaction Flow, Hyperledger Fabric Details, Fabric – Membership and Identity Management, Hyperledger Fabric Network Setup, Hyperledger Composer – Application Development.

**Use Case I:** Blockchain in Financial Service : Payments and Secure Trading, Compliance and Mortgage, Financial Trade.

**UNIT-V**

**Use Case II**: Blockchain in Supply Chain, Blockchain in Government: Digital Identity, Applications in the field of Healthcare and Education Sector.

**Use Case III:** Implications of Blockchain technology for digital privacy and Security.

## TEXT BOOKS:


1. , Imran Bashir, "Mastering Blockchain: A deep dive into distributed ledgers, consensus protocols, smart contracts, DApps, cryptocurrencies, Ethereum, and more", 3rd Edition Packt Publishing, 2020.
2. Herbert Jones, "Blockchain Create Space Independent Publishing Platform", 1st Edition, Create Space Independent Publishing Platform, 2017.


## SUGGESTED READING:


1. Josh Thom Peon, "Blockchain: The Blockchain for Beginnings, Guild to Blockchain Technology and Blockchain Programming", 1st Edition, Create Space Independent Publishing Platform, 2017.
2. Gaur and Nitin, " Hands-On Blockchain with Hyperledger: Building decentralized applications with Hyperledger Fabric", 1st Edition, Packt Publishing Ltd, 2018.
3. Larry A. DiMatteo, Michel Cannarsa, Cristina Poncib, "The Cambridge Handbook of Smart Contracts, Blockchain Technology and Digital Platforms". 1st Edition, Cambridge University Press, 2019.


## ONLINE RESOURCES:

1. https://www.packtpub.com/product/mastering-blockchain-third-edition/9781839213199
2. https://www.cse.iitk.ac.in/users/emasters/courses/Introduction%20to%20Blockchain%20Technology.ht ml
3. https://onlinecourses.nptel.ac.in/noc22_cs44/preview
4. https://onlinecourses.nptel.ac.in/noc20_cs01/preview

**26CSE131**

## ALGORITHMIC GAME THEORY

**(Professional Elective – V)**

| | |
|---|---|
| Instruction | 3 L Hours per Week |
| Duration of Semester End Examination | 3 Hours |
| Semester End Examination | 60 Marks |
| Continuous Internal Evaluation | 40 Marks |
| Credits | 3 |

**PREREQUISITE**: Mathematics and Probability, Fundamentals of algorithms and data structures, discrete mathematics and Game theory.

**COURSE OBJECTIVES:** This course aims to

1. Introduce students to the foundations of algorithmic game theory, stable matching, market equilibrium, voting, auctions, and fair division mechanisms.
2. Develop analytical and computational skills for designing and evaluating strategic decision-making algorithms in multi-agent and economic systems.
3. Enable students to understand incentive compatibility, mechanism design, social choice theory, and cooperative game-theoretic solution concepts for real-world applications..

**COURSE OUTCOMES:** After the completion of this course, the student will be able to

1. Analyse and apply stable matching algorithms, market equilibrium techniques, and fair division mechanisms in strategic environments.
2. Evaluate voting systems, social choice functions, and strategic manipulation using fundamental theorems of social choice theory.
3. Design and analyse auction mechanisms, incentive-compatible systems, and revenue-maximizing mechanisms using mechanism design principles.
4. Apply non-cooperative and cooperative game theory concepts including dominated strategies, equilibrium computation, coalition formation, and payoff allocation methods.
5. Model and solve real-world resource allocation, decision-making, and strategic interaction problems using algorithmic game theory techniques.

**CO-PO Articulation Matrix**

| PO / CO | PO 1 | PO 2 | PO 3 | PO 4 |
|---|---|---|---|---|
| **CO 1** | 3 | - | 2 | 2 |
| **CO 2** | 3 | 2 | - | 3 |
| **CO 3** | 3 | 3 | 3 | - |
| **CO 4** | 3 | 2 | 2 | 2 |
| **CO 5** | 3 | 2 | - | |

1-Slightly, 2-Moderately, 3-Substantially

**UNIT- I**

Introduction to Game Theory, Normal Form Games, Examples, Introduction to Stable Matchings, Men-Optimality of the Men-Proposing Gale-Shapley Algorithm, GS: Cheating, Strategies for Men, GS: Cheating Strategies for Women, Problem, Popular, Strategic Behaviour in Popular Matchings, Stable Roommates: Matchings in the Non-bipartite Setting.

**UNIT - II**

An Introduction to Cake-Cutting, Envy-Freenes and Approximate EF, Sperner's Lemma and Applications, Cake Cutting with a Secret Agent.

**Matrix Games:** Examples, Saddle Points, PSNE and Saddle Points, Mixed Strategies, Support Enumeration Algorithm, Succint Games, Network Congestion Games,

**UNIT - III**

An Introduction to Voting, The Game of Trust - Nicky Case's Interactive Essay, Arrow's Theorem, Gibbard-Satterethwaite Theorem, Domain Restrictions and Multi-winner Elections, Incentive Design in Crowd sourcing Applications. Social Choice Functions, Median Voter Schemes. Moulin's Characterization.

**UNIT - IV**

Second Price Auction, Strategy proof mechanisms with money. The VCG Mechanism. Weak Monotonicity. Roberts' Theorem. Second Price Auction with Reserve Price. Bayesian Mechanism Design. Myerson's Revenue-Maximizing Auction. Virtual valuations.

**UNIT - V**

Iterated elimination of strictly dominated strategies, Lemke-Howson Algorithm, Fictitious Play, Coalitional Games, Classes of Coalitional Games, Properties of Payoffs, The Shapley Value, The Core, The ε-Core, The Least Core, The Nucleolus

## TEXT BOOKS:


1. Noam Nisan, Tim Roughgarden, Éva Tardos, Vijay V. Vazirani, "Algorithmic Game Theory", 1st Edition, Cambridge University Press, 2007.
2. Tim Roughgarden, "Twenty Lectures on Algorithmic Game Theory", 1st Edition, Stanford University, California, 2016.


## SUGGESTED READING:


1. Martin J. Osborne, Ariel Rubinstein, "A Course in Game Theory", 1st Edition, MIT Press, 1994.
2. Martin J. Osborne, "An Introduction to Game Theory", 1st Edition, Oxford University Press, 2004.


## ONLINE RESOURCES:

1. Stanford CS364A – Algorithmic Game Theory
2. Stanford Algorithmic Game Theory Course Archive
3. NPTEL – Algorithmic Game Theory
4. The Evolution of Trust – Interactive Game Theory Simulation
5. GameTheory.net Educational Resources
6. Complexity Explorer – Game Theory Course
7. arXiv – Game Theory Research Papers
8. Barbados Lectures – Complexity Theory, Game Theory and Economics

**26CSE132**

## FOG AND EDGE COMPUTING
**(Professional Elective – V)**

| | |
|---|---|
| Instruction | 3 L Hours per Week |
| Duration of Semester End Examination | 3 Hours |
| Semester End Examination | 60 Marks |
| Continuous Internal Evaluation | 40 Marks |
| Credits | 3 |

**PREREQUISITE**: Internet of Thigs, Distributed Cloud Computing

**COURSE OBJECTIVES:** This course aims to
1. Introduce the fundamentals of Fog and Edge Computing and understand their role in complementing Cloud Computing.
2. Study the integration of IoT, Fog, and Cloud infrastructures for scalable and efficient distributed computing systems.
3. Explore optimization models, metrics, and service lifecycle management in Fog and Edge Computing systems

**COURSE OUTCOMES:** After the completion of this course, the student will be able to
1. Understand the basic requirements of fog and edge computing.
2. Analyze networking and management challenges in federated edge environments and describe frameworks such as EaaS and ENORM.
3. Design and evaluate integrated IoT–Fog–Cloud architectures based on different modeling techniques, use cases, and performance metrics.
4. Illustrate the role of Mobile Edge Computing, 5G network slicing, and orchestration mechanisms in modern communication infrastructures.
5. Formulate and analyze optimization problems in Fog Computing using appropriate metrics, architectural models, and service lifecycle considerations

**CO-PO Articulation Matrix**

| PO / CO | PO 1 | PO 2 | PO 3 | PO 4 |
|---|---|---|---|---|
| **CO 1** | 3 | 2 | 2 | - |
| **CO 2** | 2 | 2 | 1 | 1 |
| **CO 3** | 2 | 2 | 1 | - |
| **CO 4** | 2 | 2 | 1 | 1 |
| **CO 5** | 2 | 1 | 1 | - |

1-Slightly, 2-Moderately, 3-Substantially

**UNIT-I**

**Introduction**: Introduction to Fog Computing, Limitation of Cloud Computing, Differences between Cloud and Fog Computing. Fog and Edge Computing Completing the Cloud, Hierarchy of Fog and Edge Computing, Business Models, Opportunities and Challenges.

**UNIT-II**

**Addressing the Challenges in Federating Edge Resources**: Introduction, Networking Challenges in a Federated Edge Environment, Addressing the Networking Challenge, Management Challenges in a Federated Edge Environment, Addressing the Management Challenges, Edge-as-a-Service (EaaS) Platform, Edge Node Resource Management (ENORM) Framework.

**UNIT-III**

**Integrating IoT, Fog and Cloud Infrastructures**: Introduction, Methodology, Integrated C2F2T Literature by Modeling Technique, Integrated C2F2T Literature by Use-Case Scenarios, Integrated C2F2T Literature by Metrics.

**UNIT-IV**

**Management and Orchestration of Network Slices 5G, Fog, Edge, and Clouds:** Introduction, Mobile Edge Computing (MEC), Edge and Fog Computing, Network Slicing in 5G, Network Slicing in Software-Defined Clouds, Network Slicing Management in Edge and Fog.

**UNIT-V**

**Optimization Problems in Fog and Edge Computing:** Introduction, The Case for Optimization in Fog Computing, Formal Modeling Framework for Fog Computing, Metrics, Optimization Opportunities along the Fog Architecture, Optimization Opportunities along the Service Life Cycle, Toward a Taxonomy of Optimization Problems in Fog
Computing.

## TEXT BOOKS:


1. Rajkumar Buyya, Satish Narayana Srirama, "Fog and Edge Computing", 1st Edition, Wiley Publications, 2019.
2. Wei Change and Jie Wu, "Fog/Edge Computing for Security, Privacy and Applications", 1st Edition, Springer, 2021.


## SUGGESTED READING:


1. Amir M. Rahmani, Pasi Liljeberg, Jürgo-Sören Preden, Axel Jantsch "Fog Computing in the Internet of Things: Intelligence at the Edge", 1st Edition, Springer, 2018.
2. Rajeev Tiwari, Mamta Mittal, Lalit Mohan Goyal "Energy Conservation Solutions for Fog-Edge Computing Paradigms ", 1st Edition, Springer, 2022.
3. Rajkumar Buyya, James Broberg, Andrzej Goscinsk "Cloud Computing: Principles and Paradigms", 1st Edition, Wiley, 2011.


## ONLINE RESOURCES:

1. https://nptel.ac.in/courses/106104449
2. Coursera: Edge Computing Fundamentals

**26CSE133**

## QUANTUM COMPUTING

**(Professional Elective – V)**

| | |
|---|---|
| Instruction | 3 L Hours per Week |
| Duration of Semester End Examination | 3 Hours |
| Semester End Examination | 60 Marks |
| Continuous Internal Evaluation | 40 Marks |
| Credits | 3 |

**PREREQUISITE**: Linear algebra and probability, Quantum Mechanics.

**COURSE OBJECTIVES:** This course aims to

1. Compare classical and quantum computing (bits vs. qubits).
2. Understand the basics of quantum mechanics.
3. Design basic quantum circuits using quantum gates.
4. Examine quantum algorithms.
5. Introduce Quantum cryptography with Quantum Key Distribution protocols.

**COURSE OUTCOMES:** After the completion of this course, the student will be able to

1. Understand qubits mathematically using Dirac notation and Linear algebra for Quantum computing.
2. Apply the Postulates of quantum mechanics to quantum systems.
3. Simulate quantum circuits using quantum gates, Entanglement and Teleportation.
4. Develop quantum algorithms by constructing quantum circuits.
5. Implement Quantum cryptography for real world applications

**CO-PO Articulation Matrix**

| PO / CO | PO 1 | PO 2 | PO 3 | PO 4 |
|---|---|---|---|---|
| **CO 1** | 3 | - | 1 | 2 |
| **CO 2** | 3 | - | 3 | 2 |
| **CO 3** | 3 | - | 3 | 2 |
| **CO 4** | 3 | - | 3 | 3 |
| **CO 5** | 3 | - | 3 | 3 |

1-Slightly, 2-Moderately, 3-Substantially

**UNIT-I**

**Introduction to Quantum Computation:** Quantum bits, Superposition state, Dirac Notation, Limitations of classical computing, Classical vs quantum computation.

**Background Mathematics:** Linear algebra concepts for quantum systems, Introduction to Vector Space, Hilbet space, Subspaces, Linear Independent and Dependent vectors, Basis and Finite Dimensions, Inner Product and Outer Product, Orthogonal and Orthonormal vectors, Unitary operators and projections, Eigen values and Eigen vectors.

**UNIT-II**

**Background Physics:** Basics of quantum mechanics, Schrodinger equations, Heisenberg Uncertainity Principle and No-cloning Theorem, Tensor product, Probabilities and measurements, density matrix representation, Postulates of Quantum Mechanics.

**UNIT-III**

**Quantum Circuits: S**ingle qubit gates, Multiple qubit gates, Design of quantum circuits. **Quantum Information:** Bloch sphere representation of qubits, Quantum Entanglement, Bell states, Quantum teleportation.

**UNIT-IV**

**Quantum Algorithms:** Deutsch's algorithm, Deutsch's-Jozsa algorithm, Introduction to GCD and Congruence, Quantum Fourier Transforms, Shor's factorization algorithm, Grover's search algorithm.

**UNIT-V**

**Quantum Cryptography:** Quantum Key Distribution (QKD), BB84 QKD protocol, E91 QKD protocol, E92 QKD protocol, Security proofs for QKD, Quantum Networks.

## TEXT BOOKS:


1. Michael A.Nielsen, "Quantum Computation and Quantum Information", 10th Edition, Cambridge University Press, 2010.
2. David McMahon, "Quantum Computing Explained", 1st Edition, Wiley, 2007.


## SUGGETSED READING:


1. Jack D. Hidary, "Quantum Computing: An Applied Approach", 1st Edition, Springer, 2019.


## ONLINE RESOURCES:

1. https://nptel.ac.in/courses/106106232
2. https://quantum.cloud.ibm.com/learning/en/courses
3. https://www.coursera.org/learn/introduction-to-quantum-information

**26CSE134**

## SOCIAL NETWORK AND ANALYTICS

**(Professional Elective – V)**

| | |
|---|---|
| Instruction | 3 L Hours per Week |
| Duration of Semester End Examination | 3 Hours |
| Semester End Examination | 60 Marks |
| Continuous Internal Evaluation | 40 Marks |
| Credits | 3 |

**PREREQUISITE**: Web Technologies and Internet Basics, Basic Knowledge of Data Analytics Tools.

**COURSE OBJECTIVES:** This course aims to

3. Understand the fundamentals of social networks and graph theory.
4. Analyse the structure and dynamics of social networks.
5. Apply analytical techniques for mining and processing social network data.
6. Explore community detection, influence analysis, and recommendation systems.
7. Study real-world applications of social network analytics using modern tools and platforms.

**COURSE OUTCOMES:** After the completion of this course, the student will be able to

1. Understand the concepts, characteristics, and models of social networks.
2. Analyze social network structures using graph theory and network metrics.
3. Apply social network mining and data analytics techniques on real-world datasets.
4. Apply social network mining and data analytics techniques on real-world datasets.
5. Develop simple analytical models and applications using social network analysis tools.

**CO-PO Articulation Matrix**

| PO / CO | PO 1 | PO 2 | PO 3 | PO 4 |
|---|---|---|---|---|
| **CO 1** | 2 | 2 | 3 | 2 |
| **CO 2** | 1 | 1 | 2 | - |
| **CO 3** | 3 | 1 | 1 | 3 |
| **CO 4** | 1 | 2 | 3 | - |
| **CO 5** | 1 | 2 | 2 | 2 |

1-Slightly, 2-Moderately, 3-Substantially

**UNIT-I**

**Introduction to Social Networks,** Characteristics of Social Networks, Types of Social Media Platforms, Evolution of Social Networks, Graph Theory Basics, Nodes, Edges, Paths, Degree Distribution, Random Graphs, Small World Networks, Scale Free Networks, Network Visualization Techniques, Applications of Social Network Analysis.

**UNIT-II**

**Data Collection from Social Networks,** Web Crawling and APIs, Social Media Data Processing, Data Cleaning and Preprocessing, Sentiment Analysis, Opinion Mining, Topic Modeling, Text Analytics, Trend Analysis, Hashtag and Meme Analysis, Social Media Monitoring Techniques.

**UNIT-III**

**Community Detection Algorithms,** Modularity and Community Structures, Hierarchical Clustering, Overlapping Communities, Influence Propagation Models, Viral Marketing, Recommendation Systems, Collaborative Filtering, Content-Based Recommendation, Hybrid Recommendation Models, Case Studies on Facebook, Twitter, LinkedIn, and Instagram.

**UNIT-IV**

**Community Detection Algorithms,** Modularity and Community Structures, Hierarchical Clustering, Overlapping Communities, Influence Propagation Models, Viral Marketing, Recommendation Systems, Collaborative Filtering, Content-Based Recommendation, Hybrid Recommendation Models, Case Studies on Facebook, Twitter, LinkedIn, and Instagram.

**UNIT-V**

**Social Network Analysis Tools,** Gephi, NodeXL, NetworkX, Introduction to Neo4j Graph Database, Visualization and Dashboarding, Fake News Detection, Cyber Security Applications, Business Intelligence and Marketing Analytics, Ethical Issues and Privacy Concerns, Future Trends in Social Network Analytics.

**TEXT BOOKS:**

1. Borko Furht, "Handbook of Social Network Technologies and Applications", 1st Edition, Springer, 2010.
2. Charu C. Aggarwal, "Social Network Data Analytics", 1st Edition, Springer, 2011.
3. Reza Zafarani, Mohammad Ali Abbasi, Huan Liu, "Social Media Mining: An Introduction", 1st Edition, Cambridge University Press, 2014.

**SUGGESTED READINGS:**

1. Easley David and Jon Kleinberg, "Networks, Crowds, and Markets", 1st Ediiton, Cambridge University Press, 2010.
2. Matthew A. Russell, "Mining the Social Web", 2nd Edition, O'Reilly Media, 2013.
3. Albert-László Barabási, "Network Science", 1st Edition, Cambridge University Press, 2016.

**ONLINE RESOURCES:**

1. https://onlinecourses.nptel.ac.in/e-learning/preview/noc22_cs117

**26CSE135**

## DIGITAL FORENSICS
**(Professional Elective – V)**

| | |
|---|---|
| Instruction | 3 L Hours per Week |
| Duration of Semester End Examination | 3 Hours |
| Semester End Examination | 60 Marks |
| Continuous Internal Evaluation | 40 Marks |
| Credits | 3 |

**PREREQUISITE**: Computer Networks, Operating Systems, Cyber Security Fundamentals, and Cryptography & Network Security.

**COURSE OBJECTIVES:** This course aims to
1. Understand principles, methodologies, and legal foundations of digital forensics.
2. Analyze and investigate cyber incidents using forensic techniques.
3. Apply forensic acquisition, preservation, and evidence handling mechanisms.
4. Examine host, network, cloud, and mobile forensic artifacts.
5. Perform malware and incident forensic analysis using forensic tools.

**COURSE OUTCOMES:** After the completion of this course, the student will be able to
1. Understand digital forensic processes, legal procedures, and evidence handling mechanisms.
2. Apply forensic acquisition and preservation methods for digital evidence.
3. Analyze operating system and file system artifacts for forensic investigations.
4. Investigate network, cloud, and mobile forensic evidence.
5. Perform malware and incident response investigations using forensic tools.

**CO-PO Articulation Matrix**

| PO / CO | PO 1 | PO 2 | PO 3 | PO 4 |
|---|---|---|---|---|
| CO 1 | 3 | 3 | 2 | 2 |
| CO 2 | 3 | 3 | 3 | 2 |
| CO 3 | 3 | 3 | 2 | 3 |
| CO 4 | 3 | 3 | 3 | 3 |
| CO 5 | 3 | 3 | 3 | 3 |

1-Slightly, 2-Moderately, 3-Substantially

**UNIT-I**

**Introduction to Digital Forensics and Cyber Crime :** Introduction to Digital Forensics, Need for Digital Forensics, Types of Cyber Crimes, Digital Evidence, Forensic Process Model, Chain of Custody, Evidence Collection and Preservation, Legal and Ethical Issues, Cyber Laws, IT Act and Admissibility of Digital Evidence, Role of Digital Forensic Investigator, Standards and Best Practices in Digital Investigation.

**UNIT-II**

**Evidence Acquisition and File System Forensics:** Forensic Acquisition Process, Live vs Dead Acquisition, Disk Imaging Techniques, Bit Stream Copy, Volatile and Non-Volatile Data Collection, Data Recovery Methods, Hashing Techniques and Integrity Verification, Storage Media Analysis, Windows, Linux and Mac File Systems, NTFS, FAT, EXT File Systems, Deleted File Recovery, Registry Forensics, Timeline Analysis.

**UNIT-III**

**Operating System and Memory Forensics :** Windows Forensics, Registry Analysis, Event Logs, Browser Forensics, Email Investigation, Linux Log Analysis, Memory Forensics,Volatile Memory

Acquisition, RAM Analysis, Rootkits and Hidden Processes, Malware Indicators, Artifact Extraction and Analysis.

**UNIT-IV**

**Network, Mobile and Cloud Forensics:** Network Forensics, Packet Analysis, Traffic Monitoring, Log Analysis, Intrusion Detection Evidence, Wireless Network Forensics, Mobile Device Forensics, Android and iOS Forensics, SIM and App Data Analysis, Cloud Forensics, Challenges in Cloud Evidence Collection, Virtualization and Distributed Environment Investigation, IoT Forensics Fundamentals.

**UNIT-V**

**Malware Analysis and Incident Response Forensics:** Malware Fundamentals, Static and Dynamic Malware Analysis, Ransomware Investigation, Incident Response Process, Cyber Threat Intelligence, Log Correlation, Forensic Reporting, Documentation of Evidence, Expert Witness and Courtroom Presentation, Case Studies in Cybercrime Investigation.

## TEXT BOOKS:


1. Nelson, Phillips, Enfinger & Steuart, "Guide to Computer Forensics and Investigations", 5th Edition, Cengage Learning, 2014.
2. Eoghan Casey, "Digital Evidence and Computer Crime", 3rd Edition, Academic Press, 2011.


## SUGGESTED READINGS:


1. Michael Sikorski and Andrew Honig, "Practical Malware Analysis Practical Malware Analysis: The Hands-On Guide to Dissecting Malicious Software technical book", 1st Edition, No Starch Press, 2012
2. Sherri Davidoff and Jonathan Ham, "Network Forensics Network Forensics: Tracking Hackers Through Cyberspace technical guidebook", 1st Edition, Prentice Hal, 2012
3. Kevin Mandia, Chris Prosise, Jason T. Luttgens "Incident Response and Computer Forensics technical reference book", 2nd Edition, McGraw-Hill, 2001.
4. Albert J. Marcella Jr. and Robert S. Greenfield, "Cyber Forensics", 1st Edition, CRC Press, 2002.


## ONLINE RESOURCES:

1. NPTEL / SWAYAM – Digital Forensics Courses – Covers digital evidence, forensic tools, data recovery, and cybercrime investigation. https://onlinecourses.swayam2.ac.in/e-learning/preview/nou23_cs05
2. OpenLearn – Digital Forensics – Free introductory material on forensic investigation, digital evidence gathering, and analysis. https://www.open.edu/openlearn/science-maths-technology/digital-forensics/content-section-0?utm_source=chatgpt.com&active-tab=description-tab
3. Coursera – Digital Forensics Courses – Online certification programs on computer forensics, incident response, malware analysis, and digital evidence handling. https://www.coursera.org/courses?query=digital%20forensics&utm_source=chatgpt.com
4. edX – Digital Forensics Programs – University-level online modules in cyber forensics and investigation technique https://www.edx.org/learn/digital-forensics?utm_source

**26CSO101**

## BUSINESS ANALYTICS
**(Open Elective)**

| | |
|---|---|
| Instruction | 3 L Hours per Week |
| Duration of Semester End Examination | 3 Hours |
| Semester End Examination | 60 Marks |
| Continuous Internal Evaluation | 40 Marks |
| Credits | 3 |

**PREREQUISITE**: Basic of programming, basic mathematics.

**COURSE OBJECTIVES:** This course aims to
1. Understanding the basic concepts of business analytics and applications.
2. Study various business analytics methods including predictive, prescriptive and prescriptive analytics.
3. Prepare the students to model business data using various data mining, decision making methods.

**COURSE OUTCOMES:** After the completion of this course, the student will be able to
1. Identify and describe complex business problems in terms of analytical models.
2. Apply appropriate analytical methods to solve business problems and interpret the resulting metrics and measures to achieve stated objectives.
3. Illustrate descriptive, predictive and prescriptive analytics methods and techniques.
4. Model business data using data mining, forecasting, decision tree, and clustering techniques.
5. Design and evaluate viable data-driven solutions to complex business decision-making problems.

**CO-PO Articulation Matrix**

| PO / CO | PO 1 | PO 2 | PO 3 | PO 4 |
|---|---|---|---|---|
| **CO 1** | 3 | 1 | 2 | 2 |
| **CO 2** | 3 | 2 | 3 | 3 |
| **CO 3** | 2 | 2 | 3 | 2 |
| **CO 4** | 3 | 2 | 3 | 3 |
| **CO 5** | 3 | 3 | 3 | 3 |

1-Slightly, 2-Moderately, 3-Substantially

**UNIT - I**

**Introduction to Business Analytics:** Introduction to Business Analytics, need and science of data driven decision making, Descriptive, predictive, prescriptive analytics and techniques, Big data analytics, Web and Social media analytics, Machine Learning algorithms, Generative AI , LLMs and Explainable AI (XAI) in business analytics, framework for decision making, challenges in data driven decision making and future.

**UNIT - II**

**Descriptive Analytics:** Introduction, data types and scales, types of measurement scales, population and samples, measures of central tendency, percentile, decile and quadrille, measures of variation, measures of shape-skewness, data visualization.

**UNIT - III**

**Forecasting Techniques:** Introduction, time-series data and components, forecasting accuracy, moving average method, single exponential smoothing, Holt's method, Holt-Winter model, Croston's forecasting method, regression model for forecasting, Auto regression models, auto-regressive moving process, ARIMA, Theil's coefficient.

**UNIT - IV**

**Decision Trees:** CHAID, Classification and Regression tree, splitting criteria, Ensemble methods, Random Forest, XGBoost. Clustering: Distance and similarity measures used in clustering, clustering algorithms, K-Means, Prescriptive Analytics- Linear Programming (LP) and LP model building.

**UNIT-V**

**Six Sigma:** Introduction, origin, 3-Sigma Vs Six-Sigma process, cost of poor quality, industry applications, six sigma measures, DPMO, yield, sigma score, DMAIC methodology, Six Sigma toolbox.

## TEXTBOOKS:


1. U Dinesh Kumar, "Business Analytics", Wiley Publications, 2nd Edition, 2022
2. Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, "Business analytics Principles, Concepts, and Applications with SAS", 1st Edition, Associate Publishers, 2015


## SUGGESTED READINGS:


1. S. Christian Albright, Wayne L. Winston, "Business Analytics - Data Analysis and Decision Making", 6th Edition, Cengage, 2020.


## ONLINE RESOURCES:

1. Coursera – Business Analytics Specialization (University of Pennsylvania, Wharton): https://www.coursera.org/specializations/business-analytics
2. NPTEL – Business Analytics and Data Mining (IIT Roorkee): https://nptel.ac.in/courses/110107106
3. edX – Data Science and Analytics MicroMasters (MIT): https://www.edx.org/micromasters/mitx-statistics-and-data-science

**26MEO101**

## INDUSTRIAL SAFETY
**(Open Elective)**

| | |
|---|---|
| Instruction | 3 L Hours per Week |
| Duration of Semester End Examination | 3 Hours |
| Semester End Examination | 60 Marks |
| Continuous Internal Evaluation | 40 Marks |
| Credits | 3 |

**PREREQUISITE**:

**COURSE OBJECTIVES:** This course aims to
1. Causes for industrial accidents, preventive steps to be taken, Factories act 1948 and 5S Techniques.
2. Fundamental concepts of Maintenance Engineering.
3. About Safety in advanced manufacturing systems.
4. The basic concepts and importance of fault tracing.
5. The steps involved in periodic and preventive maintenance of various industrial equipments

**COURSE OUTCOMES:** After the completion of this course, the student will be able to
1. Identify causes of industrial accidents and recommend preventive measures.
2. Select appropriate tools and practices for various maintenance procedures.
3. Apply different Safety measures in advanced manufacturing systems.
4. Diagnose faults in equipment such as machine tools, IC engines, and boilers.
5. Implement periodic and preventive maintenance for industrial equipment including motors, pumps, air compressors, and machine tools.

**CO-PO Articulation Matrix**

| PO / CO | PO 1 | PO 2 | PO 3 | PO 4 |
|---|---|---|---|---|
| **CO 1** | 3 | 3 | 3 | 3 |
| **CO 2** | 3 | 3 | 3 | 2 |
| **CO 3** | 3 | 1 | 3 | 2 |
| **CO 4** | 3 | 1 | 3 | 2 |
| **CO 5** | 3 | 2 | 3 | 3 |

1-Slightly, 2-Moderately, 3-Substantially

**UNIT - I**

**Safety Management Concepts and Industrial Safety Practices**

**Industrial Safety & Legal Aspects:** Industrial accidents, causes, types, consequences, and preventive measures. Mechanical and electrical hazards and their control. Fire hazards, prevention and firefighting methods. Safety color codes and safety signage. Salient provisions of the Factories Act 1948 related to health, safety, and welfare.

**Safety Audit:** Types of safety audits, audit methodology, preparation of audit checklists, Non-Conformity Re- porting (NCR). Analysis and interpretation of accident records and safety reports.

**5S Techniques:** Introduction, objectives, and elements of 5S (Sort, Set in order, Shine, Standardize, Sustain). Benefits of 5S in enhancing workplace safety, productivity, and efficiency.

**UNIT - II**

**Fundamentals of Maintenance Engineering:** Definition and objectives of maintenance engineering. Primary and secondary functions and responsibilities of the maintenance department. Types of maintenance (preventive, predictive, breakdown, corrective) and their applications. Tools and equipment used in maintenance activities. Maintenance cost and its relationship with replacement decisions and economy. Concept of service life and factors affecting the lifespan of equipment.

**UNIT- III**

**Safety in advanced manufacturing systems:** Machine safety in CNC, robotics, and Flexible Manufacturing Systems (FMS). Human–machine interaction safety. Safety in Industry 4.0 environments including cyber- physical systems, smart factories, and digital twins. Safety in additive manufacturing (powder handling and laser safety). Safety in material handling systems (conveyors, cranes, AGVs) and manufacturing processes (welding, casting, forging, machining). Electrical safety in automation and Lockout/Tagout (LOTO) procedures.

**UNIT - IV**

**Fault Tracing:** Concept and importance of fault tracing. Decision tree approach – need, structure, and applications. Sequence of fault-finding activities and systematic troubleshooting procedures. Development and representation of fault diagnosis using decision trees. Fault tracing in industrial equipment including machine tools, pumps, air compressors, internal combustion engines, boilers, and electrical motors. Types of faults in machine tools and their general causes.

**UNIT - V**

**Maintenance and Condition Monitoring**

**Periodic and Preventive Maintenance:** Periodic inspection, concept and need. Cleaning, servicing, and overhauling of mechanical components and electrical motors. Common motor faults and remedies. Preventive maintenance definition, steps, and advantages. Maintenance procedures for machine tools, pumps, air compressors, and DG sets.

**Condition monitoring and basic concepts of Proactive maintenance for Industry 4.0.**

## TEXT BOOKS:


1. L. M. Deshmukh, " Industrial Safety Management", 1st Edition, McGraw Hill Education, New Delhi, 2010.
2. M.R. Sahoo, "Industrial Safety Engineering", 1st Edition, RK Publications, New Delhi, 2015.
3. H. P. Garg, "Industrial Maintenance", S. Chand and Company, 1987.
4. Das Akhil Kumar, " Principles of Industrial Safety Management Understanding the Ws of Safety at Work",2nd edition, PHI Learning Pvt Ltd, 2020.


## SUGGESTED READING:


1. Parth B. Shah, "Industrial Safety and Maintenance Engineering", Technical publications, 2021.
2. Higgins & Morrow, "Maintenance Engineering Handbook", 8th Edition, McGraw-Hill Education, 2014.
3. M.P. Poonia, S.C. Sharma, "Technology & Engineering", Khanna Publishing House, 2019.

**26MEO103**

## COMPOSITE MATERIALS
**(Open Elective)**

| | |
|---|---|
| Instruction | 3 L Hours per Week |
| Duration of Semester End Examination | 3 Hours |
| Semester End Examination | 60 Marks |
| Continuous Internal Evaluation | 40 Marks |
| Credits | 3 |

**PREREQUISITE**:

**COURSE OBJECTIVES:** This course aims to
1. Provide concepts of Composite materials and their constituents.
2. Explain the Classification of the reinforcements and matrix materials.
3. Provide Fabrication methods of metal matrix composites.
4. Explain manufacturing of Polymer matrix composites.
5. Elucidate Failure mechanisms in composite materials.

**COURSE OUTCOMES:** After the completion of this course, the student will be able to
1. Understand composite materials and their reinforcements.
2. Summarize micro-mechanics approach as applied to UD lamina.
3. Apply fabrication methods of metal, ceramic and carbon matrix composites.
4. Apply fabrication methods of polymer matrix composites..
5. Analyze the lamina and laminate from failure perspective.

**CO-PO Articulation Matrix**

| PO / CO | PO 1 | PO 2 | PO 3 | PO 4 |
|---|---|---|---|---|
| **CO 1** | 3 | 1 | 3 | 1 |
| **CO 2** | 3 | 1 | 3 | 1 |
| **CO 3** | 3 | 2 | 3 | 1 |
| **CO 4** | 3 | 2 | 3 | 1 |
| **CO 5** | 3 | 1 | 3 | 1 |

1-Slightly, 2-Moderately, 3-Substantially

**UNIT - I**

**Introduction:** Definition Classification and characteristics of Composite materials. Advantages and application of composites. Functional requirements of reinforcement and matrix. Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

**UNIT - II**

**Reinforcements**: Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements.

**Mechanical Behaviour of composites**: Rule of mixtures, Inverse rule of mixtures. Iso-strain and Iso-stress conditions.

**UNIT- III**

**Processing of Metal Matrix Composites:** Casting, Solid State diffusion technique, Cladding, Hot iso, static pressing. Properties and applications.

**Processing of Ceramic Matrix Composites:** Liquid Metal Infiltration, Liquid phase sintering.

**Processing of Carbon-Carbon composites:** Knitting, Braiding, Weaving. Properties and applications.

**UNIT - IV**

**Processing of Polymer Matrix Composites:** Preparation of Moulding compounds and prepregs, hand layup method, Autoclave method, Filament winding method, Compression moulding, Reaction injection moulding. Properties and applications.

**UNIT - V**

**Strength:** Lamina Failure Criteria, strength ratio, maximum stress criteria, maximum strain criteria, interactive failure criteria and hygrothermal failure, Laminate first ply failure, insight strength**.**

## TEXT BOOKS:


1. K.K.Chawla, "Composite Materials- Science and Engineering", 4th edition, Springer Verlag, 2019.
2. Materials Science and Engineering, An introduction. WD Callister, Jr., Adapted by R. Balasubramaniam, John Wiley & Sons, NY, Indian edition, 2007..
3. R.M. Jones. Mechanics of Composite Materials. 2 nd ed. CRC press. 2018.


## SUGGESTED READING:


1. Deborah D.L. Chung, "Composite Materials Science and Applications" 2nd edition, Springer Verlag, 2010.
2. Sanjay K. Mazumdar, "Composites Manufacturing- materials, product and process engineering", 1st Edition, CRC press, 2002.
3. Daniel Gay, "Composite Materials Design and Applications" 3rd edition, CRC press, 2015.

**26MEO104**

# ALTERNATIVE ENERGY SOURCES

**(Open Elective)**

| | |
|---|---|
| Instruction | 3 L Hours per Week |
| Duration of Semester End Examination | 3 Hours |
| Semester End Examination | 60 Marks |
| Continuous Internal Evaluation | 40 Marks |
| Credits | 3 |

**PREREQUISITE**:

**COURSE OBJECTIVES:** This course aims to

1. Need and importance of non-conventional energy resources.
2. Extent of solar energy which can be utilized as energy resource.
3. Concept of wind energy and its merits and demerits.
4. Operating principles of geothermal energy and bio-energy.
5. Merits and demerits of tidal energy, wave energy and OTEC.

**COURSE OUTCOMES:** After the completion of this course, the student will be able to

1. Understand the need for renewable energy sources in the context of environmental issues.
2. Apply the principles of solar energy for domestic and industrial usages.
3. Understand the working principle of wind power plants along with merits and demerits.
4. Describe the concepts of geothermal energy sources and biomass as a source of energy.
5. Explain the principles and impact of wave, tidal and OTEC plants on the environment.

**CO-PO Articulation Matrix**

| PO / CO | PO 1 | PO 2 | PO 3 | PO 4 |
|---|---|---|---|---|
| **CO 1** | 2 | 2 | 3 | 2 |
| **CO 2** | 3 | 2 | 3 | 1 |
| **CO 3** | 3 | 3 | 3 | 1 |
| **CO 4** | 3 | 2 | 3 | 1 |
| **CO 5** | 3 | 2 | 2 | 1 |

1-Slightly, 2-Moderately, 3-Substantially

**UNIT - I**

**Energy Sources**: Energy characteristics, forms of energy, energy chain (route), energy sectors, Indian energy scenario, energy pricing in India, energy and environment, energy security, energy conservation and its importance, energy strategy for future, classification of energy sources, availability of conventional and non- conventional (renewable) energy sources, classification of RES - solar, wind, geothermal, bio-mass, ocean tidal, ocean wave and ocean thermal energy conversion (OTEC), advantages and limitations of conventional and renewable energy sources.

**UNIT - II**

**Solar Energy**: Solar radiation, solar thermal collectors, working of flat plate and concentrating (focusing) solar collectors and their limitations, comparison of flat plate and focusing collectors, applications of solar collectors - water heating, space heating, low temperature power generation, solar cookers, water pumping, SODIS, solar thermal power plant, advantages and limitations of solar energy systems, PV materials, PV cells and their manufacturing, space based solar power (SBSP), solar satellite system, advantages and disadvantages of SBSP.

**UNIT- III**

**Wind Energy**: Sources of wind, merits and demerits of wind energy, site selection for wind energy conversion system, wind turbine (wind mill), classification of wind mills, working principle horizontal axis and vertical axis windmills, horizontal vs vertical axis windmills, power extracted from the wind, effect of velocity on power generation, new developments and problems in operating large wind power generators.

**UNIT - IV**

**Geothermal Energy:** Layers in earth, resources of geothermal energy, hydrothermal, petrothermal and geopressure resources, advantages, disadvantages, applications and environmental effects of geothermal energy sources**.**

**Biomass Energy:** Resources, biogas and its composition, process of biogas generation, wet process and dry process, raw materials available for biogas fermentation, economical, social, environmental and health benefits of biogas utilization, selection of site and constructional techniques of a biogas plant, working of KVIC, Praga- thi design, Janata and Deenbandu biogas plants, common operational problems, causes and remedies relating to a biogas plant.

**UNIT - V**

**Tidal power:** Tidal systems, site selection for tidal power plant, schematic layout of tidal power house, principle of operation of single basin and double basin tidal plants, advantages and disadvantages of tidal power.

**Wave energy -** Differences between tides and waves, advantages and disadvantages of wave power, problems associated with wave energy collection, working principle of wave energy conversion devices.

**Ocean thermal energy conversion (OTEC) -** OTEC power plants, location, open cycle and closed cycle OTEC plants, advantages, limitations and applications of OTEC, environmental impact of OTEC plants.

## TEXT BOOKS:


1. S. Hasan Saeed and D.K. Sharma, "Non-Conventional Energy Resources‖", S.K. Kataria & Sons, New Delhi, 2017.
2. Dr. R.K. Singal, "Non-Conventional Energy Resources", S.K. Kataria & Sons, New Delhi, 2005.


## SUGGESTED READING:


1. K. M. Mittal, "Non-Conventional Energy Systems", Wheeler Publishing Co. Ltd, New Delhi, 2003.
2. Shali Habibulla, ''Non-Conventional Energy Sources", State Institute of Vocational Education, Hyderabad, 2005
3. G.D. Rai, "Non-Conventional Energy Sources", Khanna Publishers, New Delhi, 2011.

**26MEO105**

## COMPUTATIONAL FLUID DYNAMICS

**(Open Elective)**

| | |
|---|---|
| Instruction | 3 L Hours per Week |
| Duration of Semester End Examination | 3 Hours |
| Semester End Examination | 60 Marks |
| Continuous Internal Evaluation | 40 Marks |
| Credits | 3 |

**PREREQUISITE**:

**COURSE OBJECTIVES:** This course aims to

1. Basic equations and concept of CFD.
2. Concept of PDEs and finite difference methods.
3. Crank-Nihcolson, Implicit and Explicit methods & Jacobi, Gauss Seidel and ADI methods.
4. Various types of grid generation and errors in numerical solution.
5. Importance of FVM.

**COURSE OUTCOMES:** After the completion of this course, the student will be able to

1. Derive CFD governing equations and turbulence models.
2. Apply different PDEs and know the importance of Taylor series of expansion.
3. Solve simultaneous linear equations with various methods.
4. Understand errors, stability, consistency and develop O,H and C grid generated models.
5. Utilize FVM for heat transfer problems.

**CO-PO Articulation Matrix**

| PO / CO | PO 1 | PO 2 | PO 3 | PO 4 |
|---|---|---|---|---|
| **CO 1** | 3 | 1 | 3 | 1 |
| **CO 2** | 3 | 1 | 3 | 1 |
| **CO 3** | 3 | 1 | 3 | 1 |
| **CO 4** | 3 | 1 | 3 | 1 |
| **CO 5** | 3 | 1 | 3 | 1 |

1-Slightly, 2-Moderately, 3-Substantially

**UNIT - I**

**Governing Equations:** Continuity, Momentum and Energy equations, Navier Stokes equations, Reynolds and Favre averaged N–S equations. Introduction to turbulence, Turbulence models-mixing length model, K-å turbulence Model.

**UNIT - II**

**Classification of PDEs:** Elliptic, parabolic and hyperbolic equations, Initial and boundary conditions. Concepts of Finite difference methods – forward, backward and central difference, explicit, Implicit and Crank Nicholson.

**UNIT- III**

**Finite Difference Solutions:** Solution of simultaneous linear equations: Jacobi, Gauss Seidel, TDMA, ADI, solution for viscous incompressible flow using Vorticity Stream function method, MAC method.

**UNIT - IV**

**Grid Generation:** Grid Generation- Types of grid O, H, C. Coordinate transformation, unstructured grid generation, Errors, Consistency, Stability analysis by von Neumann. Convergence criteria.

**UNIT - V**

**Finite Volume Method:** Introduction to Finite volume method, Finite volume formulations for diffusion equation, convection diffusion equation, staggered grids SIMPLE and SIMPLE R algorithms.

## TEXT BOOKS:


1. P.S. Ghoshdastidar, "Computational Fluid Dynamics and Heat Transfer", Cengage, 2017.
2. John D. Anderson, "Computational Fluid Dynamics", Mc Graw Hill Inc., 2018.
3. H. K. Versteeg and Malala Shekara, "Introduction to Finite Volume Method", Pearson, 2015


## SUGGESTED READING:


1. K. Muralidhar and T. Sundararajan T., "Computational Fluid flow and Heat transfer", Narosa Publishing House, 2003.
2. S.V. Patankar, "Numerical Heat transfer and Fluid flow", Hemisphere Publishing Company, New York, 1980.

**26CEO101**

## COST MANAGEMENT OF ENGINEERING PROJECTS
**(Open Elective)**

| | |
|---|---|
| Instruction | 3 L Hours per Week |
| Duration of Semester End Examination | 3 Hours |
| Semester End Examination | 60 Marks |
| Continuous Internal Evaluation | 40 Marks |
| Credits | 3 |

**PREREQUISITE**:

**COURSE OBJECTIVES:** This course aims to

1. Enable the students to understand the concepts of Project management.
2. Provide knowledge on concepts of Project Planning and scheduling.
3. Create an awareness on Project Monitoring and Cost Analysis
4. Provide adequate knowledge to the students on Recourse Management Costing-Variance Analysis
5. Train the students with the concepts of Budgetary Control for cost management and to provide basic platform on Quantitative techniques for cost management

**COURSE OUTCOMES:** After the completion of this course, the student will be able to

1. Acquire in-depth knowledge about the concepts of project management and understand the principles of project management
2. Determine the critical path of a typical project using CPM and PERT techniques.
3. Prepare a work break down plan and perform linear scheduling using various methods.
4. Solve problems of resource scheduling and levelling using network diagrams.
5. Learn the concepts of budgetary control and apply quantitative techniques for optimizing project cost

**CO-PO Articulation Matrix**

| PO / CO | PO 1 | PO 2 | PO 3 | PO 4 |
|---|---|---|---|---|
| **CO 1** | 1 | 1 | - | 1 |
| **CO 2** | 1 | 2 | 1 | 1 |
| **CO 3** | 1 | 1 | 1 | 1 |
| **CO 4** | 2 | 2 | 1 | 1 |
| **CO 5** | - | 1 | 1 | 1 |

1-Slightly, 2-Moderately, 3-Substantially

**UNIT-I**

**Project Management:** Introduction to project managements, stakeholders, roles, responsibilities and functional relationships. Principles of project management, objectives and project management system. Project team, organization, roles, and responsibilities. Concepts of project planning, monitoring, staffing, scheduling and controlling.

**UNIT-II**

**Project Planning and Scheduling:** Introduction for project planning, defining activities and their interdependency, time and resource estimation. Work break down structure. Linear scheduling methods-bar charts, Line of Balance (LOB), their limitations. Principles, definitions of network-based scheduling methods: CPM, PERT. Network representation, network analysis-forward and backward passes.

**UNIT-III**

**Project Monitoring and Cost Analysis:** introduction-Cost concepts in decision making; relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory

valuation; Creation of a Database for operational control; Provision of data for Decision- Making, Time cost trade off Crashing project schedules, its impact on time on time, cost. Project direct and indirect costs.

**UNIT-IV**

**Resources Management and Costing-Variance Analysis:** Planning, Enterprise Resource Planning, Resource scheduling and levelling. Total Quality Management and Theory of constraints. Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis

**Standard Costing and Variance Analysis.** Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement

**UNIT-V**

**Boundary Budgetary Control: Flexible Budgets;** Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.

**Quantitative techniques for cost management:** Linear Programming, PERT/CPM, Transportation Assignment problems, Simulation, Learning Curve Theory.

## TEXT BOOKS:


1. Charles T Horngren "Cost Accounting A Managerial Emphasis", Pearson Education; 14th Edition 2012.
2. Charles T. Horngren and George Foster, "Advanced Management Accounting" Prentice-Hall; 6th revised edition, 1987.
3. Robert S Kaplan Anthony A. Atkinson, "Management & Cost Accounting", Pearson; 2nd Edition, 1996.


## SUGGESTED READING:


1. K. K Chitkara, "Construction Project Management: Planning, scheduling and controlling", Tata Mc Graw Hill Education, 2004.
2. Kumar Neeraj Jha "Construction Project Management Theory and Practice", Pearson Education India, 2nd Edition, 2015.

**26EEO104**

## WASTE TO ENERGY
**(Open Elective)**

| | |
|---|---|
| Instruction | 3 L Hours per Week |
| Duration of Semester End Examination | 3 Hours |
| Semester End Examination | 60 Marks |
| Continuous Internal Evaluation | 40 Marks |
| Credits | 3 |

**PREREQUISITE**: Students should have prior knowledge of Energy Conversions

**COURSE OBJECTIVES:** This course aims to
1. Know the various forms of waste.
2. Extraction of Energy from Waste.
3. Infer the Global and national scenario.

**COURSE OUTCOMES:** After the completion of this course, the student will be able to
1. Understand the concept of waste energy.
2. Explore the various Energy extraction options.
3. Describe the Energy Production methodology.
4. Explain the Environmental implications.
5. Compare and contrast waste energy productions by case studies.

**CO-PO Articulation Matrix**

| PO / CO | PO 1 | PO 2 | PO 3 | PO 4 |
|---|---|---|---|---|
| **CO 1** | 2 | 1 | 1 | 1 |
| **CO 2** | 3 | 1 | 2 | 2 |
| **CO 3** | 2 | 1 | 2 | 2 |
| **CO 4** | 2 | 2 | 1 | 2 |
| **CO 5** | 3 | 2 | 2 | 3 |

1-Slightly, 2-Moderately, 3-Substantially

**UNIT-I**

**Introduction:** The Principles of Waste Management and Waste Utilization. Waste Management Hierarchy and 3R Principle of Reduce, Reuse and Recycle. Waste as a Resource and Alternate Energy source. Waste Sources & Characterization Waste production in different sectors such as domestic, industrial, agriculture, postconsumer, waste etc. Classification of waste – agro based, forest residues, domestic waste, industrial waste (hazardous and non-hazardous). Characterization of waste for energy utilization. Waste Selection criteria, Smart waste management systems (IoT-based monitoring).

**UNIT-II**

**Energy Extraction Options:** Landfill gas, collection and recovery. Refuse Derived Fuel (RDF), fluff, briquettes, pellets. Alternate Fuel Resource (AFR)–production and use in Cement plants, Thermal power plants and Industrial boilers. Conversion of wastes fuel resources for other useful energy applications Energy from Plastic Wastes: Non-recyclable plastic wastes for energy recovery. Energy Recovery from waste and optimization of its use, benchmarking and standardization. Energy Analysis

**UNIT-III**

**Energy production Methodologies:** Collection, segregation, transportation and storage requirements. Location and Siting of 'Waste Energy' plants. Industry Specific Applications: In-house use: sugar, distillery, pharmaceuticals, Pulp and paper, refinery and petrochemical industry and any other industry.

Centralized and Decentralized Energy production, distribution and use. Comparison of Centralized and decentralized systems and its operations

**UNIT-IV**

Environmental Implications: Environmental standards for Waste Energy Plant operations and gas clean-up. Savings on non-renewable fuel resources. Carbon Credits: Carbon foot calculations and carbon credits transfer mechanisms

**UNIT-V**

Case Studies: Success/failures of waste energy Global Best Practices in Waste energy production distribution and use. Indian Scenario on Waste Energy production distribution and use in India. Success and Failures of Indian Waste Energy plants. Role of the Government in promoting 'Waste Energy ", Government policies & PPP models, Future trends: AI in waste management, circular economy

## TEXT BOOKS:


1. "Industrial and Urban Waste Management in India", TERI Press.
2. Banwari Lal and Patwardhan, "Wealth from Waste: Trends and Technologies" TERI Press.
3. S.N Mukhopadhyay, "Fundamentals of waste and Environmental engineering", TERI Press.
4. "Waste-to-Energy in Austria – White Book – Figures, Data Facts", 2nd edition, May 2010.


## SUGGESTED READING:


1. CPCB Guidelines for Co-processing in Cement/Power/Steel Industry
2. Report of the task Force on Waste Energy, Niti Ayog (Formerly Planning Commission) 2014.
3. Municipal Solid Waste Management Manual, CPHEEO, 2016
4. Gazette Notification on Waste Management Rules 2016.


## ONLINE RESOURCES:

1. Waste to Energy Conversion –Prof. P. Mondal (Instructor), IIT Roorke (Host Institute)
2. https://nptel.ac.in/courses/103107125

**26PYO101**

## HISTORY OF SCIENCE AND TECHNOLOGY

**(Open Elective)**

| | |
|---|---|
| Instruction | 3 L Hours per Week |
| Duration of Semester End Examination | 3 Hours |
| Semester End Examination | 60 Marks |
| Continuous Internal Evaluation | 40 Marks |
| Credits | 3 |

**PREREQUISITE**:

**COURSE OBJECTIVES:** This course aims to

1. Gains the knowledge about origin of science in the Stone Age and its progress during Antiquity period.
2. Familiar with scientific views in the Medieval period and during the Industrial revolution..
3. Aware of modern scientific developments from 19$^{th}$ century onwards.

**COURSE OUTCOMES:** After the completion of this course, the student will be able to

1. Demonstrate the process of beginning of science and civilization, knowledge acquisition and philosophical approach of science and its advancements in the Stone Ages and Antiquity period.
2. Illustrate the advancements in science and technology in the medieval period across Asia and Arab countries and decline and revival of science in Europe.
3. Explain the scientific approach and its advances of the Europeans and how the role of engineer during the industrial revolution and the major advancements.
4. Make use of the advancements in the field of science and technology by adopting new philosophies of 19$^{th}$ and first half of 20$^{th}$ century in finding ethical solutions to the societal problems.
5. Interpret the changes in specializations of science and the technology and build the relation between information and society from second half of 20$^{th}$ century onwards..

**CO-PO Articulation Matrix**

| PO / CO | PO 1 | PO 2 | PO 3 | PO 4 |
|---|---|---|---|---|
| **CO 1** | 1 | 2 | 1 | 1 |
| **CO 2** | 1 | 1 | 1 | 2 |
| **CO 3** | 1 | 1 | 1 | 1 |
| **CO 4** | 1 | 1 | 1 | 1 |
| **CO 5** | - | 1 | 2 | 1 |

1-Slightly, 2-Moderately, 3-Substantially

**UNIT-I**

**Science - The Beginning (through 599 BCE):** The Stone Ages, Knowledge among hunter gatherers, Agricultural Revolution and other revolutions, Civilization, Major advances.

**Science in Antiquity (600 BCE - 529 CE):** Philosophy- a precursor to science, Hellenistic world and the Roman Empire, Other cultures of the period, Major advances.

**UNIT-II**

**Medieval Science (530 CE - 1452 CE):** The decline of science in Europe, Science in China, Science and mathematics in India, Arab science, Revival of science in Europe, Technology revolution of the Middle ages, Major advances.

**The Renaissance and the Scientific Revolution (1453 CE – 1659 CE):** Renaissance, Scientific Revolution, Technology, Major advances.

**UNIT-III**

**Scientific Method: Measurement and Communication (1660 CE – 1734 CE):** European domination, The scientific method, Major advances.

**The Industrial Revolution (1735 CE – 1819 CE):** Industrial Revolution, Rise of the engineer, Major Advances.

**UNIT-IV**

**Science and Technology in the 19th Century (1820 CE – 1894 CE): P**hilosophical basis of 19th-century science, Science and the public, Science and technology, Major advances.

**Rise of Modern Science and Technology (1895 CE – 1945 CE):** The growth of 20$^{th}$century science, new philosophies, Quantum reality, Energy sources, Electricity: a revolution in technology, Major advances.

**UNIT-V**

**Big Science and the Post-Industrial Society (1946 CE – 1972 CE):** Big science, Specialization and changing categories, Technology changes society, Major advances.

**The Information Age (1973 CE – 2015 CE):** Information and society, Globalization, The post-industrial society, Problems of the Information age, Major Advances

## TEXT BOOKS:


1. Bryan Bunch and Alexander Hellemans, "The History of Science and Technology", Houghton Mifflin Company (New York), 2004
2. JD Bernal, "Science in History", 4 Volumes, Eklavya Publishers, 2012


## SUGGESTED READING:


1. Kara Rogers, "The 100 Most Influential Scientists of All Time", Britannica Educational Publishing, 2010
2. Alberto Hernandez, "A Visual History of Science and Technology", The Rosen Publishing Group, 2016.

**26CSC111**

## DISSERTATION PHASE-I

| | |
|---|---|
| Instruction | 20 P Hours per Week |
| Duration of Semester End Examination | - |
| Semester End Examination | - |
| Continuous Internal Evaluation | 100 Marks |
| Credits | 10 |

**PREREQUISITE**: Research Methodologies and IPR, Basic knowledge of problem solving.

**COURSE OUTCOMES:** After the completion of this course, the student will be able to

1. Identify and analyse real-world problems.
2. Formulate the solutions using the appropriate methodology.
3. Design the solution with appropriate design diagrams.
4. Set up the test-bed, prepare the data, and generate preliminary results.
5. Communicate the work in written and oral forms.

**CO-PO Articulation Matrix**

| PO / CO | PO 1 | PO 2 | PO 3 | PO 4 |
|---|---|---|---|---|
| **CO 1** | 3 | 3 | 2 | - |
| **CO 2** | 3 | - | 3 | - |
| **CO 3** | 3 | 2 | 2 | - |
| **CO 4** | 3 | - | - | - |
| **CO 5** | 3 | 3 | - | - |

1-Slightly, 2-Moderately, 3-Substantially

### Guidelines:

1. Students shall select a real-world problem with relevant research domain during the first two weeks of commencement of coursework of the semester.
2. The topic of the dissertation must be mutually decided by the supervisor and the student. Students shall be in regular contact with their supervisor(s).
3. Students shall submit an abstract duly signed by the Supervisor(s) to the Departmental Review Committee (DRC) in the 3rd week after the commencement of the classwork.
4. Students shall carry out a thorough literature review and gather/generate the required data for their respective problem statement.
5. Formulate a solution for the chosen problem by ensuring novelty.
6. They shall present a seminar based on the problem chosen for their dissertation work.
7. The CIE shall include time to time reviews and preparation of the report consisting of a detailed problem statement and preliminary results (if available) of the problem along with the design.
8. The work carried out by the student shall be presented in front of the committee consisting of the Head & Chairman of BoS, Supervisor(s), DRC and PG Coordinator at the last week of the course work.

| **CIE Assessment Guidelines Max Marks: 100** | | |
|---|---|---|
| **Evaluation by** | **Max. Marks** | **Evaluation Criteria** |
| Supervisor | 30 | Project Status / Review(s) |
| | 20 | Report |
| Departmental Review Committee (DRC) | 10 | Relevance of the topic |
| | 10 | PPT Preparation(s) |
| | 10 | presentation(s) |
| | 10 | Question and Answers |
| | 10 | Report preparation |

Note: Departmental Review Committee has to assess the every two weeks.

**CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY**
**R26 (In line with AICTE Model Curriculum) with effect from AY 2026-27**

**M. Tech. (Computer Science and Engineering)**

**SEMESTER – IV**

| S. No | Course Code | Title of the Course | Scheme of Instruction | | | Scheme of Examination | | | Credits |
|---|---|---|---|---|---|---|---|---|---|
| | | | Hours per Week | | | Duration of SEE in Hours | Maximum Marks | | |
| | | | L | T | P/D | | CIE | SEE | |
| **DISSERATATION** | | | | | | | | | |
| 2. | 26CSC112 | Dissertation Phase-II | - | - | 32 | - | 100 | 100 | 16 |
| **Total** | | | **-** | **-** | **32** | **-** | **100** | **100** | **16** |

**L: Lecture** **D: Drawing** **CIE: Continuous Internal Evaluation**
**T: Tutorial** **P: Practical/Dissertation** **SEE-Semester End Examination**

| | CREDIT SUMMARY | | | |
|---|---|---|---|---|
| **SEMESTER** | **I** | **II** | **III** | **IV** |
| **CREDITS** | **16** | **17** | **19** | **16** |
| **Total :** | | | | **68** |

**26CSC112**

## DISSERTATION PHASE-II

| | |
|---|---|
| Instruction | 32 P Hours per Week |
| Duration of Semester End Examination | - |
| Semester End Examination | 100 Marks |
| Continuous Internal Evaluation | 100 Marks |
| Credits | 16 |

**PREREQUISITE**: Research Methodologies and IPR, Basic knowledge of problem solving, Technical Writing.

**COURSE OUTCOMES:** After the completion of this course, the student will be able to

1. Use different experimentation techniques and technologies.
2. Conduct experiments by using the benchmark data sets.
3. Analyse and interpret the results by using appropriate modern tools.
4. Communicate the work effectively with technical reports and oral presentations.
5. Make research contributions by publishing their work to the research community

**CO-PO Articulation Matrix**

| PO / CO | PO 1 | PO 2 | PO 3 | PO 4 |
|---|---|---|---|---|
| **CO 1** | 3 | - | 3 | - |
| **CO 2** | 3 | - | 2 | - |
| **CO 3** | 3 | - | 3 | - |
| **CO 4** | - | 3 | - | - |
| **CO 5** | - | 3 | 2 | 3 |

1-Slightly, 2-Moderately, 3-Substantially

It is a continuation of Dissertation Phase-I the student has to initiate the course work of Dissertation Phase II.

**The Guidelines to be followed:**

1. Students shall attend the reviews as per the schedule notified by DRC with the proper report and presentation.
2. The dissertation work shall be presented in a prescribed format as provided by the DRC.
3. Students have to prepare a detailed dissertation report which consisting of an introduction, problem statement, literature review, objectives of the work, methodology, results, discussions, conclusions of the work and future scope as per the format provided by DRC.
4. The Internal viva-voce of the Dissertation work has to be presented in front of the committee consisting of HoD & BoS Chairperson, and a Supervisor(s)/Co-supervisor.
5. Their final Dissertation work has to be presented in front of the committee consisting of an approved external examiner, an internal examiner (HoD & BoS Chairperson) and a Supervisor(s)/Co-supervisor.
6. The students are strictly advised to meet their Supervisor(s)/co-supervisor regularly.

| **CIE Assessment Guidelines Max Marks: 100** | | |
|---|---|---|
| **Evaluation by** | **Max. Marks** | **Evaluation Criteria** |
| Supervisor | 05 | Review-1 |
| | 10 | Review-2 |
| | 10 | Review-3 |
| | 15 | Final presentation with the draft copy of the report in a standard format |
| | 10 | Submission of the report |
| Departmental | 10 | Regularity and Punctuality |

| | | |
|---|---|---|
| Review Committee (DRC) | 10 | Work Progress |
| | 10 | Quality of work which may lead to publication |
| | 10 | Analytical Programming / Experimental Skills Preparation |
| | 10 | Report preparation in a standard format |

| **SEE Assessment Guidelines** | | **Max Marks: 100** |
|---|---|---|
| **Evaluation by** | **Max. Marks** | **Evaluation Criteria** |
| Supervisor | 20 | Power Point Presentation |
| | 40 | Quality of dissertation report and Evaluation |
| Departmental Review Committee (DRC) | 20 | Quality of the Dissertation:<br>• Innovations<br>• Applications<br>• Live Research work<br>• Scope for future study<br>• Application to Society<br>• Regularity and Punctuality |
| | 20 | Viva-Voce |

**Note:** Departmental Review Committee shall assess the progress of the student for every TWO weeks.