ST. JOSEPH'S
COLLEGE OF ENGINEERING
AND TECHNOLOGY,
- PALAI -
AUTONOMOUS

Choondacherry P.O., Pala, Kottayam - 686579
Kerala, India

# S3 & S4 SYLLABUS

## B. Tech.

## Artificial Intelligence and Data Science

## 2024 Scheme

2024 SCHEME



Signed By:Devassia V P
Reason: Approved by SJCET Academic Council held on 13.05.2025

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# SEMESTER – III

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sl. No: | Slot | Course Code | Course Type | Course Category | Course Title (Course Name) | Credit Structure | | | | SS | Total Marks | | Credits | Hrs./ Week |
| | | | | | | L | T | P | R | | CIE | ESE | | |
| 1 | A | 24SJGAMAT301 | BSC | GC | Mathematics for Computer and Information Science-3 | 3 | 0 | 0 | 0 | 4.5 | 40 | 60 | 3 | 3 |
| 2 | B | 24SJPCAIT302 | PC | PC | Foundations of Artificial Intelligence | 3 | 1 | 0 | 0 | 5 | 40 | 60 | 4 | 4 |
| 3 | C | 24SJPCCST303 | PC | PC | Data Structures and Algorithms | 3 | 1 | 0 | 0 | 5 | 40 | 60 | 4 | 4 |
| 4 | D | 24SJPBADT304 | PC-PBL | PB | Introduction to Data Science | 3 | 0 | 0 | 1 | 5.5 | 60 | 40 | 4 | 4 |
| 5 | F | 24SJGAEST305 | ESC | GC | Digital Electronics & Logic Design | 3 | 1 | 0 | | 5 | 40 | 60 | 4 | 4 |
| 6 | G S3/ S4 | 24SJICHUT346 | HMC | IC | Economics for Engineers | 2 | 0 | 0 | 0 | 3 | 50 | 50 | 2 | 2 |
| | | 24SJICHUT347 | | | Engineering Ethics and Sustainable Development | | | | | | | | | |
| 7 | L | 24SJPCCSL307 | PCL | PC | Data Structures Lab | 0 | 0 | 3 | 0 | 1.5 | 50 | 50 | 2 | 3 |
| 8 | Q | 24SJPCCDL308 | PCL | PC | Python and Statistical Modelling Lab | 0 | 0 | 3 | 0 | 1.5 | 50 | 50 | 2 | 3 |
| 9 | R/M | | VAC | | Remedial/Minor Course | 3 | 1 | 0 | 0 | 5 | | | 4* | 4* |
| **Total** | | | | | | | | | | **31 / 36** | | | **25/29*** | **27/31*** |
| **Bridge Course for Lateral Entry Students: Total 15 Hrs.** | | | | | | | | | | | | | | |

## SEMESTER S3

## MATHEMATICS FOR COMPUTER AND INFORMATION SCIENCE-3

| | | | |
|---|---|---|---|
| **Course Code** | **24SJGAMAT301** | **CIE Marks** | 40 |
| **Teaching Hours/Week (L: T:P: R)** | 3:0:0:0 | **ESE Marks** | 60 |
| **Credits** | 3 | **Exam Hours** | 2 Hrs. 30 Min. |
| **Prerequisites (if any)** | Basic calculus | **Course Type** | Theory |

**Course Objectives:**

1. To familiarize students with the foundations of probability and analysis of random processes used in various applications in engineering and science.

### SYLLABUS

| Module No. | Syllabus Description | Contact Hours |
|---|---|---|
| 1 | Random variables, Discrete random variables and their probability distributions, Cumulative distribution function, Expectation, Mean and variance, the Binomial probability distribution, the Poisson probability distribution, Poisson distribution as a limit of the binomial distribution, Joint pmf of two discrete random variables, Marginal pmf, Independent random variables, Expected value of a function of two discrete variables.<br><br>**[Text 1: Relevant topics from sections 3.1 to 3.4, 3.6, 5.1, 5.2]** | **9** |
| 2 | Continuous random variables and their probability distributions, Cumulative distribution function, Expectation, Mean and variance, Uniform, Normal and Exponential distributions, Joint pdf of two Continuous random variables, Marginal pdf, Independent random variables, Expectation value of a function of two continuous variables.<br><br>**[Text 1: Relevant topics from sections 3.1, 4.1, 4.2, 4.3, 4.4, 5.1, 5.2]** | **9** |

| | | |
|---|---|---|
| **3** | Limit theorems: Markov's Inequality, Chebyshev's Inequality, Strong Law of Large Numbers (Without proof), Central Limit Theorem (without proof), Stochastic Processes: Discrete-time process, Continuous-time process, Counting Processes, The Poisson Process, Interarrival times (Theorems without proof)<br><br>**[Text 2: Relevant topics from sections 2.7, 2.9, 5.3]** | **9** |
| **4** | Markov Chains, Random Walk Model, Chapman–Kolmogorov Equations, Classification of States, Irreducible Markov chain, Recurrent state, Transient state, Long-Run Proportions. (Theorems without proof)<br><br>**[Text 2: Relevant topics from sections 4.1, 4.2, 4.3, 4.4]** | **9** |

**Course Assessment Method**
**(CIE: 40 marks, ESE: 60 marks)**

**Continuous Internal Evaluation Marks (CIE):**

| Attendance | Assignment/ Microproject | Internal Examination-1 (Written) | Internal Examination- 2 (Written) | Total |
|---|---|---|---|---|
| 5 | 15 | 10 | 10 | 40 |

**End Semester Examination Marks (ESE)**

*In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions*

| Part A | Part B | Total |
|---|---|---|
| • 2 Questions from each module.<br>• Total of 8 Questions, each carrying 3 marks<br><br>**(8x3 =24 marks)** | • Each question carries 9 marks.<br>• Two questions will be given from each module, out of which 1 question should be answered.<br>• Each question can have a maximum of 3 sub divisions.<br><br>**(4x9 = 36 marks)** | **60** |

## Course Outcomes (COs)

At the end of the course students should be able to:

| Course Outcome | | Bloom's Knowledge Level (KL) |
|---|---|---|
| **CO1** | Understand the concept, properties and important models of discrete random variables and to apply in suitable random phenomena. | **K3** |
| **CO2** | Understand the concept, properties and important models of continuous random variables and to apply in suitable random phenomena. | **K3** |
| **CO3** | Familiarize and apply limit theorems and to understand the fundamental characteristics of stochastic processes. | **K3** |
| **CO4** | Solve problems involving Markov Chains, to understand their theoretical foundations and to apply them to model and predict the behaviour of various stochastic processes. | **K3** |

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

**CO-PO Mapping Table:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | - | 2 | - | - | - | - | - | - | 2 |
| **CO2** | 3 | 3 | - | 2 | - | - | - | - | - | - | 2 |
| **CO3** | 3 | 3 | - | 2 | - | - | - | - | - | - | 2 |
| **CO4** | 3 | 3 | - | 2 | - | - | - | - | - | - | 2 |

| Text Books | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| **1** | Probability and Statistics for Engineering and the Sciences | Devore J. L | Cengage Learning | 9th edition, 2016 |
| **2** | Introduction to Probability Models | Sheldon M. Ross | Academic Press | 13th edition, 2024 |

| Reference Books | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| **1** | Probability and Random Processes for Electrical and Computer Engineers | John A. Gubner | Cambridge University Press | 2012 |
| **2** | Probability Models for Computer Science | Sheldon M. Ross | Academic Press | 1st edition, 2001 |
| **3** | Probability, Random Variables and Stochastic Processes | Papoulis, A. & Pillai, S.U. | Tata McGraw Hill. | 4th edition, 2002 |
| **4** | Probability, Statistics and Random Processes | Kousalya Pappu | Pearson | 2013 |

| Video Links (NPTEL, SWAYAM…) | |
|---|---|
| **Module No.** | **Link ID** |
| **1, 2** | https://onlinecourses.nptel.ac.in/noc22_mg31/preview |
| **3, 4** | https://archive.nptel.ac.in/courses/108/103/108103112/ |

## SEMESTER S3

## FOUNDATIONS OF ARTIFICIAL INTELLIGENCE

| | | | |
|---|---|---|---|
| **Course Code** | **24SJPCAIT302** | **CIE Marks** | 40 |
| **Teaching Hours/Week (L: T:P: R)** | 3:1:0:0 | **ESE Marks** | 60 |
| **Credits** | 4 | **Exam Hours** | 2 Hrs. 30 Min. |
| **Prerequisites (if any)** | None | **Course Type** | Theory |

**Course Objectives:**

1. Introduce the fundamental principles of intelligent systems.
2. Impart a good insight into the characteristics of intelligent systems, knowledge representation schemes, logic and inference mechanisms.

### SYLLABUS

| Module No. | Syllabus Description | Contact Hours |
|---|---|---|
| 1 | **Introduction to Artificial intelligence:-** AI definition - Foundations of AI, History and applications of AI; Intelligent agents - Agents and Environments, The concept of rationality, The nature of environments, Structure of agents. | 7 |
| 2 | **Problem Solving by Searching:-** Problem Solving Agents and examples - Searching for Solutions; Uninformed Search strategies - Breadth First Search, Uniform Cost Search, Depth First Search, Depth Limited Search, Iterative deepening DFS; Heuristic function; Informed Search Strategies - Greedy Search, A* Search, AO* Search. | 13 |
| 3 | **Advanced Search and Game Playing:-** Adversarial Search - Games, Optimal decisions in Games, MinMax algorithm, Alpha_Beta pruning; Constraint Satisfaction Problems- Constraint Propagation, Inferences in CSP's, Backtracking Search for CSP's. | 10 |
| 4 | **Knowledge, Logic, and Reasoning Patterns:-** Knowledge Based Agents - The Wumpus World; Logic - Propositional Logic; First order logic - Syntax and Semantics, Using First Order Logic, Knowledge Engineering in First order logic, Inference in first order logic; Propositional vs. first order inference; Unification & Lifting; Forward chaining; Backward chaining. | 14 |

**Course Assessment Method**

**(CIE: 40 marks, ESE: 60 marks)**

**Continuous Internal Evaluation Marks (CIE):**

| Attendance | Assignment/ Microproject | Internal Examination-1 (Written) | Internal Examination- 2 (Written) | Total |
|---|---|---|---|---|
| 5 | 15 | 10 | 10 | 40 |

**End Semester Examination Marks (ESE)**

*In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions*

| Part A | Part B | Total |
|---|---|---|
| • 2 Questions from each module.<br>• Total of 8 Questions, each carrying 3 marks<br>**(8x3 =24 marks)** | • Each question carries 9 marks.<br>• Two questions will be given from each module, out of which 1 question should be answered.<br>• Each question can have a maximum of 3 subdivisions.<br>**(4x9 = 36 marks)** | **60** |

**Course Outcomes (COs)**

At the end of the course students should be able to:

| | Course Outcome | Bloom's Knowledge Level (KL) |
|---|---|---|
| **CO1** | Explain the fundamental concepts of intelligent systems. | **K2** |
| **CO2** | Apply searching strategies for real time scenarios. | **K3** |
| **CO3** | Apply Constraint satisfaction problems for real time scenarios. | **K3** |
| **CO4** | Apply methods of knowledge representation and processing within expert systems. | **K3** |

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

**CO-PO Mapping Table:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | | | | | | | | 2 |
| **CO2** | 3 | 3 | 3 | 2 | | | | | | | 2 |
| **CO3** | 3 | 3 | 3 | 2 | | | | | | | 2 |
| **CO4** | 3 | 3 | 3 | 2 | | | | | | | 2 |

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

| **Text Books** | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| **1** | Artificial Intelligence – A Modern Approach | Stuart Russel, Peter Norvig | Pearson Education | 4/e, 2021 |

| **Reference Books** | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| **1** | Artificial Intelligence: A new Synthesis | J. Nilsson | Elsevier Publishers. | 1/e, 1998 |
| **2** | Computational Intelligence: A logical approach | David Poole, Alan Mackworth, Randy Goebel | Oxford University Press | 1/e, 2004 |
| **3** | Artificial Intelligence: Structures and Strategies for Complex Problem Solving | George F. Luger | Pearson Education | 6/e, 2009 |

| **Video Links (NPTEL, SWAYAM…)** | |
|---|---|
| **Module No.** | **Link ID** |
| **1** | https://onlinecourses.nptel.ac.in/noc21_ge20/preview |
| **2** | https://onlinecourses.swayam2.ac.in/cec21_cs08/preview |

# SEMESTER 3

## DATA STRUCTURES AND ALGORITHMS

(Common to CS/CA/AD/CC)

| | | | |
|---|---|---|---|
| **Course Code** | **24SJPCCST303** | **CIE Marks** | 40 |
| **Teaching Hours/Week (L: T:P: R)** | 3:1:0:0 | **ESE Marks** | 60 |
| **Credits** | 4 | **Exam Hours** | 2 Hrs. 30 Min. |
| **Prerequisites (if any)** | 24SJICEST105 & 24SJGXEST204 | **Course Type** | Theory |

**Course Objectives:**

1. To provide the learner a comprehensive understanding of data structures and algorithms.
2. To prepare them for advanced studies or professional work in computer science and related fields.

## SYLLABUS

| Module No. | Syllabus Description | Contact Hours |
|---|---|---|
| 1 | **Basic Concepts of Data Structures**<br>Definitions; Data Abstraction; Performance Analysis - Time & Space Complexity, Asymptotic Notations- Definition of Big Oh, Omega, Theta, Problems on Big Oh.<br>Polynomial representation using Arrays, Sparse matrix (*Tuple representation*); Stacks and Queues - Stacks, Queues, Circular Queues, Double Ended Queues; Evaluation of Expressions- Infix to Postfix, Evaluating Postfix Expressions. | **11** |
| 2 | **Linked List and Memory Management**<br>Singly Linked List - Operations on Linked List, Stacks and Queues using Linked List, Polynomial representation using Linked List; Doubly Linked List; Circular Linked List;<br>Memory allocation - First-fit, Best-fit, and Worst-fit allocation schemes (Concept and Problems Only); | **11** |

| | | |
|---|---|---|
| **3** | **Trees and Graphs**<br>Trees: - Representation of Trees; Binary Trees - Types and Properties, Binary Tree Representation, Tree Traversals; Expression Trees; Binary Search Trees - Binary Search Tree Operations; Binary Heaps - Binary Heap Operations.<br>Graphs: - Definitions; Representation of Graphs; Depth First Search and Breadth First Search; Applications of Graphs. | **11** |
| **4** | **Sorting and Searching**<br>Sorting Techniques: - Selection Sort, Insertion Sort, Quick Sort, Merge Sort, Heap Sort, Radix Sort.<br>Searching Techniques: - Linear Search, Binary Search, Hashing - Hashing functions: Mid square, Division, Folding, Digit Analysis; Collision Resolution: Linear probing, Quadratic Probing, Double hashing, Open hashing. | **11** |

**Course Assessment Method**
**(CIE: 40 marks, ESE: 60 marks)**

**Continuous Internal Evaluation Marks (CIE):**

| Attendance | Assignment/ Microproject | Internal Examination-1 (Written) | Internal Examination- 2 (Written) | Total |
|---|---|---|---|---|
| **5** | **15** | **10** | **10** | **40** |

**End Semester Examination Marks (ESE)**

*In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions*

| Part A | Part B | Total |
|---|---|---|
| • 2 Questions from each module.<br>• Total of 8 Questions, each carrying 3 marks<br>**(8x3 =24 marks)** | • Each question carries 9 marks.<br>• Two questions will be given from each module, out of which 1 question should be answered.<br>• Each question can have a maximum of 3 sub divisions.<br>**(4x9 = 36 marks)** | **60** |

## Course Outcomes (COs)

At the end of the course students should be able to:

| Course Outcome | | Bloom's Knowledge Level (KL) |
|---|---|---|
| **CO1** | Identify appropriate data structures for solving real world problems. | **K3** |
| **CO2** | Describe and implement linear data structures such as arrays, linked lists, stacks, and queues. | **K3** |
| **CO3** | Describe and implement non-linear data structures such as trees and graphs. | **K3** |
| **CO4** | Select appropriate searching and sorting algorithms to be used in specific circumstances. | **K3** |

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

**CO-PO Mapping Table:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | ✓* | ✓ | ✓ | | | | | | | | ✓ |
| **CO2** | ✓ | ✓ | ✓ | | | | | | | | ✓ |
| **CO3** | ✓ | ✓ | ✓ | | | | | | | | ✓ |
| **CO4** | ✓ | ✓ | ✓ | | | | | | | | ✓ |

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*
**Correlation value will be fixed in the course committee meeting*

| Text Books | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| 1 | Fundamentals of Data Structures in C | Ellis Horowitz, Sartaj Sahni and Susan Anderson-Freed, | Universities press | 2/e, 2007 |
| 2 | Introduction to Algorithms | Thomas H Cormen, Charles Leisesrson, Ronald L Rivest, Clifford Stein | PHI | 3/e, 2009 |

| Reference Books | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| 1 | Classic Data Structures | Samanta D. | Prentice Hall India. | 2/e, 2018 |
| 2 | Data Structures and Algorithms | Aho A. V., J. E. Hopcroft and J. D. Ullman | Pearson Publication. | 1/e, 2003 |
| 3 | Introduction to Data Structures with Applications | Tremblay J. P. and P. G. Sorenson | Tata McGraw Hill. | 2/e, 2017 |
| 4 | Theory and Problems of Data Structures | Lipschuts S. | Schaum's Series | 2/e, 2014 |

| Video Links (NPTEL, SWAYAM…) | |
|---|---|
| **Module No.** | **Link ID** |
| 1 | https://nptel.ac.in/courses/106102064 |
| 2 | https://ocw.mit.edu/courses/6-851-advanced-data-structures-spring-2012/ |

## SEMESTER S3

## INTRODUCTION TO DATA SCIENCE

| | | | |
|---|---|---|---|
| **Course Code** | **24SJPBADT304** | **CIE Marks** | 60 |
| **Teaching Hours/Week (L: T:P: R)** | 3:0:0:1 | **ESE Marks** | 40 |
| **Credits** | 4 | **Exam Hours** | 2 Hrs. 30 Min. |
| **Prerequisites (if any)** | None | **Course Type** | Theory |

**Course Objectives:**

1. To understand the basic concepts of data science
2. To understand data representation, data pre-processing, data classification and model evaluation techniques

## SYLLABUS

| Module No. | Syllabus Description | Contact Hours |
|---|---|---|
| **1** | **Introduction to data**:– Structured, Unstructured, Semi-structured, Data sets & Patterns; Brief history of Data Science; Introduction to Data Science; Importance of Data Science; Differences between AI, ML, DL, Data Science & Data Analytics; Real world applications of data science; Steps in data science process.<br><br>Ethical and privacy implications of Data Science; Tools and Skills Needed – Introduction of platforms, Tools, Frameworks, Languages, Databases and Libraries, Current trends & Major research challenges in data science | **9** |
| **2** | Matrices to represent relations between data, and necessary linear algebraic operations on matrices -Approximately representing matrices by decompositions (SVD and PCA); Statistics: Descriptive Statistics: distributions and probability – Statistical Inference: Populations and samples – Statistical modeling – probability distributions – fitting a model – Hypothesis Testing | **10** |
| **3** | Data pre-processing: Data cleaning – data integration – Data Reduction Data Transformation and Data Discretization. - Evaluation of classification methods – Confusion matrix, Students T-tests and | **13** |

| | | |
|---|---|---|
| | ROC curves-Exploratory Data Analysis – Basic tools (plots, graphs and summary statistics) of EDA, Philosophy of EDA | |
| **4** | Basic Machine Learning Algorithms- Linear Regression- Logistic Regression – Classifiers - Feature Generation and Feature Selection – Feature Selection algorithms – Filters- Wrappers-Decision Trees- Random Forests | **11** |

***Suggestion on Project Topics***

- Students can implement various data related projects, from any domain, using the techniques studied in the syllabus. It may contain sections for data storage, data pre-processing and small levels of data mining to recognize patterns in the data. Socially relevant project domains are highly appreciated. Check the datasets available at https://www.kaggle.com/datasets/ and perform data pre-processing operations such as data cleaning, missing value management and mine useful information from the dataset.

**Course Assessment Method**

**(CIE: 60 marks, ESE: 40 marks)**

**Continuous Internal Evaluation Marks (CIE):**

| Attendance | Project | Internal Ex-1 | Internal Ex-2 | Total |
|---|---|---|---|---|
| **5** | **30** | **12.5** | **12.5** | **60** |

**End Semester Examination Marks (ESE)**

*In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions*

| Part A | Part B | Total |
|---|---|---|
| • 2 Questions from each module.<br>• Total of 8 Questions, each carrying 2 marks<br><br>**(8x2 =16 marks)** | • 2 questions will be given from each module, out of which 1 question should be answered.<br>• Each question can have a maximum of 2 subdivisions.<br>• Each question carries 6 marks.<br><br>**(4x6 = 24 marks)** | **40** |

## Course Outcomes (COs)

At the end of the course students should be able to:

| Course Outcome | | Bloom's Knowledge Level (KL) |
|---|---|---|
| **CO1** | Recall the fundamental concepts and applications of data science, and make inferences on key important points. | **K2** |
| **CO2** | Comprehend the various methods of data representation | **K2** |
| **CO3** | Analyse the different steps in data pre-processing and model evaluation | **K3** |
| **CO4** | Perform feature generation and feature selection for classification | **K3** |

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

**CO-PO Mapping Table:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | | | | | | | | |
| **CO2** | 3 | 3 | 3 | 2 | | | | | | | |
| **CO3** | 3 | 3 | 3 | 2 | | | | | | | |
| **CO4** | 3 | 3 | 3 | 2 | | | | | | | |

| Text Books | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| **1** | Data mining Concepts and Techniques | Jiawei Han, Michelin Kamber, Jian Pei | Morgan Kaufmann Publishers | 3/e, 2011 |
| **2** | Fundamentals of Data Science | Sanjeev J. Wagh, Manisha S. Bhende, and Anuradha D. Thakare | CRC Press | 1/e, 2021 |
| **3** | Data Mining and Analysis: Fundamental Concepts and Algorithms | Mohammed J. Zaki and Wagner Miera Jr | Cambridge University Press | 1/e2014. |
| **4** | Doing Data Science, Straight Talk From The Frontline | Cathy O'Neil and Rachel Schutt | O'Reilly | 1/e2014 |

| Reference Books |
|---|

| Sl. No | Title of the Book | Name of the Author/s | Name of the Publisher | Year |
|---|---|---|---|---|
| 1 | Data Science for Business | Foster Provost, Tom Fawcett | O'Reilly Media | 1/e, 2013 |
| 2 | Data Science from Scratch: First Principles with Python", | Joel Grus, | O'Reilly Media | 1/e, 2015 |
| 3 | Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython", | Wes McKinney, | O'Reilly Media | 1/e,2012 |

| Video Links (NPTEL, SWAYAM…) | |
|---|---|
| **Module No.** | **Link ID** |
| 1 | https://nptel.ac.in/courses/106106179 |
| 2 | https://onlinecourses.swayam2.ac.in/imb23_mg64/preview |

## PBL Course Elements

| L: Lecture (3 Hrs.) | R: Project (1 Hr.), 2 Faculty Members | | |
|---|---|---|---|
| | **Tutorial** | **Practical** | **Presentation** |
| Lecture delivery | Project identification | Simulation/ Laboratory Work/ Workshops | Presentation (Progress and Final Presentations) |
| Group discussion | Project Analysis | Data Collection | Evaluation |
| Question answer Sessions/ Brainstorming Sessions | Analytical thinking and self-learning | Testing | Project Milestone Reviews, Feedback, Project reformation (If required) |
| Guest Speakers (Industry Experts) | Case Study/ Field Survey Report | Prototyping | Poster Presentation/ Video Presentation: Students present their results in a 2 to 5 minutes video |

## Assessment and Evaluation for Project Activity

| Sl. No | Evaluation for | Allotted Marks |
|---|---|---|
| 1 | Project Planning and Proposal | 5 |
| 2 | Contribution in Progress Presentations and Question Answer Sessions | 4 |
| 3 | Involvement in the project work and Team Work | 3 |
| 4 | Execution and Implementation | 10 |
| 5 | Final Presentations | 5 |
| 6 | Project Quality, Innovation and Creativity | 3 |
| **Total** | | **30** |

1. **Project Planning and Proposal (5 Marks)**

- Clarity and feasibility of the project plan
- Research and background understanding
- Defined objectives and methodology

2. **Contribution in Progress Presentation and Question Answer Sessions (4 Marks)**

- Individual contribution to the presentation
- Effectiveness in answering questions and handling feedback

3. **Involvement in the Project Work and Team Work (3 Marks)**

- Active participation and individual contribution
- Teamwork and collaboration

4. **Execution and Implementation (10 Marks)**

- Adherence to the project timeline and milestones
- Application of theoretical knowledge and problem-solving
- Final Result

5. **Final Presentation (5 Marks)**

   - Quality and clarity of the overall presentation
   - Individual contribution to the presentation
   - Effectiveness in answering questions

6. **Project Quality, Innovation, and Creativity (3 Marks)**

   - Overall quality and technical excellence of the project
   - Innovation and originality in the project
   - Creativity in solutions and approaches

# SEMESTER 3

## DIGITAL ELECTRONICS AND LOGIC DESIGN

| | | | |
|---|---|---|---|
| **Course Code** | **24SJGAEST305** | **CIE Marks** | 40 |
| **Teaching Hours/Week (L:T:P: R)** | 3:1:0:0 | **ESE Marks** | 60 |
| **Credits** | 4 | **Exam Hours** | 2 Hrs. 30 Min. |
| **Prerequisites (if any)** | None | **Course Type** | Theory |

**Course Objectives:**

1. To familiarize the basic concepts of Boolean algebra and digital systems.
2. To enable the learner to design simple combinational and sequential logic circuits which is essential in understanding organization & design of computer systems.

## SYLLABUS

| Module No. | Syllabus Description | Contact Hours |
|---|---|---|
| 1 | **Number systems, Operations & Codes**<br>Decimal, Binary, Octal and Hexadecimal Number Systems- Number Base Conversions. Addition, Subtraction, Multiplication and Division of binary numbers. Representation of negative numbers- Complements, Subtraction with complements. Addition and subtraction of BCD, Octal and Hexadecimal numbers. Binary codes- Decimal codes, Error detection codes, Reflected code, Character coding schemes – ASCII, EBCDIC.<br>Basics of Verilog - basic language elements: identifiers, data objects, scalar data types, operators. | 11 |

| | | |
|---|---|---|
| **2** | **Boolean Algebra**<br><br>Postulates of Boolean Algebra. Basic theorems and Properties of Boolean Algebra. Boolean Functions - Canonical and Standard forms. Simplification of Boolean Functions- Using Karnaugh- Map Method (up to four variables), Don't care conditions, Product of sums simplification, Tabulation Method. Digital Logic gates- Implementation of Boolean functions using basic and universal gates. Modeling in Verilog, Implementation of gates with simple Verilog codes. | **11** |
| **3** | **Combinational Logic Circuits**<br><br>Design Procedure & Implementation of combinational logic circuits- Binary adders and subtractors, Binary Parallel adder, Carry look ahead adder, BCD adder, Code converter, Magnitude comparator, Decoder, De-multiplexer, Encoder, Multiplexer, Parity generator/ Checker. Modeling and simulation of combinatorial circuits with Verilog codes at the gate level. | **10** |
| **4** | **Sequential logic circuits:**<br><br>Flip-flops- SR, JK, T and D. Triggering of flip-flops- Master slave flip- flops, Edge- triggered flip- flops. Excitation table and characteristic equation. Registers- register with parallel load. Counter design: Asynchronous counters- Binary and BCD counters, timing sequences and state diagrams. Synchronous counters- Binary Up- down counter, BCD counter.<br>**Shift registers**<br>Shift registers – Serial In Serial Out, Serial In Parallel Out, Bidirectional Shift Register with Parallel load. Ring counter. Johnson counter- timing sequences and state diagrams.<br>**Programmable Logic devices**<br>ROM, Programmable Logic Array (PLA)- Implementation of simple circuits using PLA. Modeling and simulation of flip-flops and counters in Verilog. | **12** |

**Course Assessment Method**
**(CIE:40 marks, ESE: 60 marks)**

**Continuous Internal Evaluation Marks (CIE):**

| Attendance | Assignment/ Microproject | Internal Examination-1 (Written) | Internal Examination- 2 (Written ) | Total |
|---|---|---|---|---|
| 5 | 15 | 10 | 10 | 40 |

**End Semester Examination Marks (ESE)**

*In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions*

| Part A | Part B | Total |
|---|---|---|
| • 2 Questions from each module.<br>• Total of 8 Questions, each carrying 3 marks.<br>**(8x3 =24 marks)** | • Each question carries 9 marks.<br>• Two questions will be given from each module, out of which 1 question should be answered.<br>• Each question can have a maximum of 3 subdivisions.<br>**(4x9 = 36 marks)** | **60** |

**Course Outcomes (COs)**

At the end of the course students should be able to:

| | Course Outcome | Bloom's Knowledge Level (KL) |
|---|---|---|
| **CO1** | Illustrate decimal, binary, octal, hexadecimal and BCD number systems, perform conversions among them and do the operations - complementation, addition, subtraction, multiplication and division on binary numbers | **K2** |
| **CO2** | Simplify a given Boolean Function and design a combinational circuit to implement the simplified function using Digital Logic Gates | **K3** |
| **CO3** | Design combinational circuits - Adders, Code Convertors, Decoders, Magnitude Comparators, Parity Generator/Checker. | **K3** |
| **CO4** | Design sequential circuits - Registers, Counters and Shift Registers | **K3** |

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

**CO-PO Mapping Table:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | ✓ | ✓ | ✓ | | | | | | | | ✓ |
| **CO2** | ✓ | ✓ | ✓ | ✓ | | | | | | | ✓ |
| **CO3** | ✓ | ✓ | ✓ | ✓ | | | | | | | ✓ |
| **CO4** | ✓ | ✓ | ✓ | ✓ | | | | | | | ✓ |

*Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*
**Correlation value will be fixed in the course committee meeting*

| **Text Books** | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| 1 | Introduction to Logic Circuits & Logic Design with Verilog | Brock J. LaMeres | Springer International Publishing | 2/e, 2017 |
| 2 | Digital Logic & Computer Design | M. Morris Mano | Pearson | 4/e, 2013 |

| **Reference Books** | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| 1 | Digital Design with an Introduction to the Verilog HDL, VHDL, and System Verilog | M Morris Mano, Michael D Ciletti | Pearson | 6/e, 2018 |
| 2 | Digital Fundamentals | Thomas Floyd | Pearson | 11/e, 2015 |
| 3 | Fundamentals of Digital Logic with Verilog Design | Stephen Brown, Zvonko Vranesic | McGraw Hill | 3/e, 2014 |
| 4 | Switching and Finite Automata Theory | Zvi Kohavi Niraj K. Jha | Cambridge University Press | 3/e, 2010 |

| **Video Links (NPTEL, SWAYAM…)** | |
|---|---|
| **Sl. No.** | **Link ID** |
| **1** | https://nptel.ac.in/courses/117105080 |
| **2** | https://onlinecourses.nptel.ac.in/noc21_ee39/ |
| **3** | https://onlinecourses.nptel.ac.in/noc24_cs61/ |

# SEMESTER 3/4

# ECONOMICS FOR ENGINEERS

| | | | |
|---|---|---|---|
| **Course Code** | **24SJICHUT346** | **CIE Marks** | **50** |
| **Teaching Hours/Week (L: T:P: R)** | **2:0:0:0** | **ESE Marks** | **50** |
| **Credits** | **2** | **Exam Hours** | **2 Hrs. 30 Min.** |
| **Prerequisites (if any)** | **None** | **Course Type** | **Theory** |

**Course Objectives:**

1. Understanding of finance and costing for engineering operation, budgetary planning and control
2. Provide fundamental concept of micro and macroeconomics related to engineering industry
3. Deliver the basic concepts of Value Engineering.

## SYLLABUS

| Module No. | Syllabus Description | Contact Hours |
|---|---|---|
| 1 | Basic Economics Concepts - Basic economic problems – Production Possibility Curve – Utility – Law of diminishing marginal utility – Law of Demand - Law of supply – Elasticity - measurement of elasticity and its applications – Equilibrium- Changes in demand and supply and its effects<br>Production function - Law of variable proportion – Economies of Scale – Internal and External Economies – Cobb-Douglas Production Function | 6 |
| 2 | Cost concepts – Social cost, private cost – Explicit and implicit cost – Sunk cost - Opportunity cost - short run cost curves - Revenue concepts<br>Firms and their objectives – Types of firms – Markets - Perfect Competition – Monopoly - Monopolistic Competition - Oligopoly (features and equilibrium of a firm) | 6 |
| 3 | Monetary System – Money – Functions - Central Banking –Inflation - Causes and Effects – Measures to Control Inflation - Monetary and Fiscal policies – Deflation Taxation – Direct and Indirect taxes (merits and demerits) - GST<br>National income – Concepts - Circular Flow – Methods of Estimation and Difficulties - Stock Market – Functions- Problems faced by the Indian stock market-Demat Account and Trading Account – Stock market<br>Indicators- SENSEX and NIFTY | 6 |

| | | |
|---|---|---|
| 4 | Value Analysis and value Engineering - Cost Value, Exchange Value, Use Value, Esteem Value - Aims, Advantages and Application areas of Value Engineering - Value Engineering Procedure - Break-even Analysis - Cost-Benefit Analysis - Capital Budgeting - Process planning | 6 |

**Course Assessment Method**

**(CIE: 50 marks, ESE: 50 marks)**

**Continuous Internal Evaluation Marks (CIE):**

| Attendance | Assignment/ Case study/ Micro project | Internal Examination-1 (Written) | Internal Examination- 2 (Written) | Total |
|---|---|---|---|---|
| 10 | 15 | 12.5 | 12.5 | 50 |

**End Semester Examination Marks (ESE)**

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

| Part A | Part B | Total |
|---|---|---|
| Minimum 1 and Maximum 2 Questions from each module. Total of 6 Questions, each carrying 3 marks<br><br>**(6x3 =18marks)** | 2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks.<br>**(4x8 = 32 marks)** | **50** |

**Course Outcomes (COs)**

At the end of the course students should be able to:

| Course Outcome | | Bloom's Knowledge Level (KL) |
|---|---|---|
| **CO1** | Understand the fundamentals of various economic issues using laws and learn the concepts of demand, supply, elasticity and production function. | **K2** |
| **CO2** | Develop decision making capability by applying concepts relating to costs and revenue, and acquire knowledge regarding the functioning of firms in different market situations. | **K3** |
| **CO3** | Outline the macroeconomic principles of monetary and fiscal systems, national income and stock market. | **K2** |
| **CO4** | Make use of the possibilities of value analysis and engineering, and solve simple business problems using break even analysis, cost benefit analysis and capital budgeting techniques. | **K3** |

*Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

**CO-PO Mapping Table:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | - | - | - | - | - | 1 | - | - | - | - | 1 |
| CO2 | - | - | - | - | - | 1 | 1 | - | - | - | 1 |
| CO3 | - | - | - | - | 1 | - | - | - | - | - | 2 |
| CO4 | - | - | - | - | 1 | 1 | - | - | - | - | 2 |

| Text Books | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| 1 | Managerial Economics | Geetika, Piyali Ghosh and Chodhury | Tata McGraw Hill, | 2015 |
| 2 | Engineering Economy | H. G. Thuesen, W. J. Fabrycky | PHI | 1966 |
| 3 | Engineering Economics | R. Paneerselvam | PHI | 2012 |

| Reference Books | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| 1 | Engineering Economy | Leland Blank P.E, Anthony Tarquin P. E. | Mc Graw Hill | 7TH Edition |
| 2 | Indian Financial System | Khan M. Y. | Tata McGraw Hill | 2011 |
| 3 | Engineering Economics and analysis | Donald G. Newman, Jerome P. Lavelle | Engg. Press, Texas | 2002 |
| 4 | Contemporary Engineering Economics | Chan S. Park | Prentice Hall of India Ltd | 2001 |

# SEMESTER 3

## DATA STRUCTURES LAB

(Common to CS/CA/AD/CC)

| | | | |
|---|---|---|---|
| **Course Code** | **24SJPCCSL307** | **CIE Marks** | 50 |
| **Teaching Hours/Week (L: T:P: R)** | 0:0:3:0 | **ESE Marks** | 50 |
| **Credits** | 2 | **Exam Hours** | 2 Hrs. 30 Min. |
| **Prerequisites (if any)** | 24SJGXEST204 | **Course Type** | Lab |

**Course Objectives:**

To give practical experience for learners on implementing different linear and non linear data structures, and algorithms for searching and sorting.

| Expt. No. | Experiments |
|---|---|
| 1 | Find the sum of two polynomials using arrays |
| 2 | Find the sum of two sparse matrices and transpose the resultant matrix. |
| 3 | Convert infix expression to postfix (or prefix) and then evaluate using stack. |
| 4 | Implement Queue, DEQUEUE, and Circular Queue using arrays. |
| 5 | Implement Circular Queue using arrays. |
| 6 | Implement backward and forward navigation of visited web pages in a web browser (i.e. back and forward buttons) using doubly linked list operations. |
| 7 | Implement addition of polynomials using singly linked lists. |
| 8 | Create a binary tree for a given simple arithmetic expression and find the prefix / postfix equivalent. |
| 9 | Implement binary search trees by performing insertion, search and deletion of numbers using linked list. |
| 10 | Implement BFS using arrays. |
| 11 | Implement the find and replace feature in a text editor |
| 12 | Given an array of sorted items, implement an efficient algorithm to search for specific item in the array and also find the time and space complexities. |
| 13 | Implement Bubble sort, Insertion Sort, Quick Sort, and Merge Sort and compare the number of steps involved. |
| 14 | Simulation of a basic memory allocator and garbage collector using doubly linked list |
| 15 | The CSE dept is organizing a tech fest with so many exciting events. By participating in an event, you can claim for activity points as stipulated by KTU. Each event i gives you A[i] activity points where A is an array. If you are not allowed to participate in more than k events, what's the max number of points that you can earn? |
| 16 | You are given a hash table with 10 slots (indexed from 0 to 9). You are also provided with a set of integers that need to be inserted into the hash table using a hash function. |

**Course Assessment Method**

**(CIE: 50 marks, ESE: 50 marks)**

**Continuous Internal Evaluation Marks (CIE):**

| Attendance | Preparation/Pre-Lab Work experiments, Viva and Timely completion of Lab Reports / Record (Continuous Assessment) | Internal Examination | Total |
|---|---|---|---|
| 5 | 25 | 20 | 50 |

**End Semester Examination Marks (ESE):**

| Procedure/ Preparatory work/Design / Algorithm | Conduct of experiment/ Execution of work/ troubleshooting/ Programming | Result with valid inference/ Quality of Output | Viva voce | Record | Total |
|---|---|---|---|---|---|
| 10 | 15 | 10 | 10 | 5 | 50 |

- ***Submission of Record: Students shall be allowed for the end semester examination only upon submitting the duly certified record.***
- ***Endorsement by External Examiner:*** *The external examiner shall endorse the record*

**Course Outcomes (COs)**

At the end of the course students should be able to:

| | Course Outcome | Bloom's Knowledge Level (KL) |
|---|---|---|
| **CO1** | Model a real-world problem using suitable data structure and implement the solution. | **K3** |
| **CO2** | Compare efficiency of different data structures in terms of time and space complexity. | **K4** |
| **CO3** | Evaluate the time complexities of various searching and sorting algorithms. | **K4** |
| **CO4** | Differentiate static and dynamic data structures in terms of their advantages and application. | **K3** |

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

**CO- PO Mapping (Mapping of Course Outcomes with Program Outcomes)**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | ✓ | ✓ | ✓ | ✓ | | | | ✓ | | | ✓ |
| **CO2** | ✓ | ✓ | ✓ | ✓ | | | | ✓ | | | ✓ |
| **CO3** | ✓ | ✓ | ✓ | ✓ | | | | ✓ | | | ✓ |
| **CO4** | ✓ | ✓ | ✓ | ✓ | | | | ✓ | | | ✓ |

*1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*
**Correlation value will be fixed in the course committee meeting*

| **Text Books** | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| 1 | Fundamentals of Data Structures in C | Ellis Horowitz, Sartaj Sahni and Susan Anderson-Freed, | Universities Press, | 2/e, 2007 |
| 2 | Introduction to Algorithms | Thomas H Cormen, Charles Leisesrson, Ronald L Rivest, Clifford Stein | PHI | 3/e, 2009 |

| **Reference Books** | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| 1 | Classic Data Structures | Samanta D. | Prentice Hall India. | 2/e, 2018 |
| 2 | Data Structures and Algorithms | Aho A. V., J. E. Hopcroft and J. D. Ullman | Pearson Publication. | 1/e, 2003 |
| 3 | Introduction to Data Structures with Applications | Tremblay J. P., P. G. Sorenson | Tata McGraw Hill. | 2/e, 2017 |
| 4 | Theory and Problems of Data Structures | Lipschutz S. | Schaum's Series | 2/e, 2014 |

| **Video Links (NPTEL, SWAYAM…)** | |
|---|---|
| **No.** | **Link ID** |
| **1** | https://nptel.ac.in/courses/106102064 |
| **2** | https://ocw.mit.edu/courses/6-851-advanced-data-structures-spring-2012/ |

## Continuous Assessment (25 Marks)

1. **Preparation and Pre-Lab Work (7 Marks)**
   - Pre-Lab Assignments: Assessment of pre-lab assignments or quizzes that test understanding of the upcoming experiment.
   - Understanding of Theory: Evaluation based on students' preparation and understanding of the theoretical background related to the experiments.
2. **Conduct of Experiments (7 Marks)**
   - Procedure and Execution: Adherence to correct procedures, accurate execution of experiments, and following safety protocols.
   - Skill Proficiency: Proficiency in handling equipment, accuracy in observations, and troubleshooting skills during the experiments.
   - Teamwork: Collaboration and participation in group experiments.
3. **Lab Reports and Record Keeping (6 Marks)**
   - Quality of Reports: Clarity, completeness and accuracy of lab reports. Proper documentation of experiments, data analysis and conclusions.
   - Timely Submission: Adhering to deadlines for submitting lab reports/rough record and maintaining a well-organized fair record.
4. **Viva Voce (5 Marks)**
   - Oral Examination: Ability to explain the experiment, results and underlying principles during a viva voce session.

***Final Marks Averaging: The final marks for preparation, conduct of experiments, viva, and record are the average of all the specified experiments in the syllabus.***

## Evaluation Pattern for End Semester Examination (50 Marks)

1. **Procedure/Preliminary Work/Design/Algorithm (10 Marks)**
   - Procedure Understanding and Description: Clarity in explaining the procedure and understanding each step involved.
   - Preliminary Work and Planning: Thoroughness in planning and organizing materials/equipment.
   - Algorithm Development: Correctness and efficiency of the algorithm related to the experiment.
   - Creativity and logic in algorithm or experimental design.

2. **Conduct of Experiment/Execution of Work/Programming (15 Marks)**

- Setup and Execution: Proper setup and accurate execution of the experiment or programming task.

3. **Result with Valid Inference/Quality of Output (10 Marks)**

- Accuracy of Results: Precision and correctness of the obtained results.
- Analysis and Interpretation: Validity of inferences drawn from the experiment or quality of program output.

4. **Viva Voce (10 Marks)**

- Ability to explain the experiment, procedure results and answer related questions
- Proficiency in answering questions related to theoretical and practical aspects of the subject.

5. **Record (5 Marks)**

- Completeness, clarity, and accuracy of the lab record submitted

# SEMESTER S3

## PYTHON AND STATISTICAL MODELING LAB
## (Common to AD/CD/CR)

| | | | |
|---|---|---|---|
| **Course Code** | **24SJPCCDL308** | **CIE Marks** | 50 |
| **Teaching Hours/Week (L: T:P: R)** | 0:0:3:0 | **ESE Marks** | 50 |
| **Credits** | 2 | **Exam Hours** | 2 Hrs. 30 Min. |
| **Prerequisites (if any)** | None | **Course Type** | Lab |

**Course Objectives:**

1. The course aims to familiarize students with basic Python concepts and data structures, model graphical representation of data, measures of central tendency and measures of dispersion. The course will also introduce students to use python in solving problems based on statistical distributions, regression analysis and correlation tests

| Expt. No. | Experiments |
|---|---|
| 1 | Write a program to find the largest of three numbers. |
| 2 | Write a program to print the multiplication table of a number n. |
| 3 | Write a program to find Surface area and volume of a cylinder using function. |
| 4 | Write a program to replace a word by another word in a sentence. |
| 5 | Write a program to confirm the validity of an email id by verifying its format. |
| 6 | Write a program to remove every occurrence of a number from a list. |
| 7 | Write a program to add two matrices. |
| 8 | Write a program to read a tuple of numbers and print even tuple and odd tuple. |
| 9 | Create a dictionary with a set of book title and corresponding stock. Write a program to update the stock and to add or delete books. |
| 10 | A set of numbers are stored in a file. Write a program to print the prime numbers among them. |
| 11 | Write a program to count the number of words, sentences, upper case letters, lowercase letters and special symbols in a text stored in file. |
| 12 | Plot a graph y = f(x) |
| 13 | The areas of the various continents of the world (in millions of square miles) are as follows:11.7 for Africa; 10.4 for Asia; 1.9 for Europe; 9.4 for North America; 3.3 Oceania; 6.9 South America; 7.9<br>Soviet Union. Draw a bar chart representing the given data. |
| 14 | Draw the histogram of the following data: |

| **Height of student(m)** | 135 - 140 | 140 - 145 | 145-150 | 150-155 |
|---|---|---|---|---|
| **No. of students** | 4 | 12 | 16 | 8 |

**15** Table contains population and murder rates (in units of murders per 100,000 people per year) for different states. Compute the mean, median and variance for the population.

| State | Population | Murder |
|---|---|---|
| Alabama | 4,779,736 | 5.7 |
| Alaska | 710231 | 5.6 |
| Arizona | 6,392,017 | 4.7 |
| Arkansas | 2,915,918 | 5.6 |
| California | 37,253,956 | 4.4 |
| Colorado | 5,029,196 | 2.8 |
| Connecticut | 3,574,097 | 2.4 |
| Delaware | 89,924 | 5.8 |

**16** Calculate the S.D. and coefficient of variation (C.V.) for the following table:

| **Class:** | 0-10 | 10-20 | 20-30 | 30-40 | 40-50 | 50-60 | 60-70 | 70-80 |
|---|---|---|---|---|---|---|---|---|
| **Frequency:** | 5 | 10 | 20 | 40 | 30 | 20 | 10 | 5 |

**17** If X is binomially distributed with 6 trials and a probability of success equal to 0.25 at each attempt, what is the probability of:
a) exactly 4 successes b) at least one success

**18** If the random variable X follows a Poisson distribution with mean 3.4, find P(X=6).

**19** A random sample of 395 people were surveyed and each person was asked to report the highest education level they obtained. The data that resulted from the survey is summarized in the following table. Are gender and education level dependent at 5% level of significance?

| | High School | Bachelors | Masters | Ph.D | Total |
|---|---|---|---|---|---|
| Female | 60 | 54 | 46 | 41 | 201 |
| Male | 40 | 44 | 53 | 57 | 194 |
| Total | 100 | 98 | 99 | 98 | 395 |

**20** Calculate the correlation coefficient of the two variables shown in the table below.

| Person | Hand | Height |
|---|---|---|
| A | 17 | 150 |
| B | 15 | 154 |
| C | 19 | 169 |
| D | 17 | 172 |
| E | 21 | 175 |

**21** Suppose a sample of 16 light trucks is randomly selected off the assembly line. The trucks are driven 1000 miles and the fuel mileage (MPG) of each truck is recorded. It is found that the mean MPG is 22 with a SD equal to 3. The previous model of the light truck got 20 MPG. Conduct a t- test of the null hypothesis at p = 0.05.

**22** The mean productivity rating for all employees at a company was 3.8 on a five- point scale last year. This year you get ratings from a representative sample of fifteen employees from the Human Research Management. Do the data from this sample provide evidence that employee productivity in the department of Human Resource Management is significantly higher than in the company as a whole? Write the null and alternative hypotheses for this problem. Use statistical analysis software to test the null hypothesis stated above.

**23** Obtain the regression equation for predicting systolic blood pressure from job statistical analysis software. If one knows that a subject in the future has a score on job satisfaction of 15, what is their systolic blood pressure predicted to be? What is the standard error of estimate?

| | | Job Satisfaction | Systolic BP | |
|---|---|---|---|---|
| | | 34 | 124 | |
| | | 23 | 128 | |
| | | 19 | 157 | |
| | | 43 | 133 | |
| | | 56 | 116 | |
| | | 47 | 125 | |
| | | 32 | 147 | |
| | | 16 | 167 | |
| | | 55 | 110 | |
| | | 25 | 156 | |

**Course Assessment Method**
**(CIE: 50 marks, ESE: 50 marks)**

**Continuous Internal Evaluation Marks (CIE):**

| Attendance | Preparation/Pre-Lab Work experiments, Viva and Timely completion of Lab Reports / Record (Continuous Assessment) | Internal Examination | Total |
|---|---|---|---|
| 5 | 25 | 20 | 50 |

**End Semester Examination Marks (ESE):**

| Procedure/ Preparatory work/Design /Algorithm | Conduct of experiment/ Execution of work/ troubleshooting/ Programming | Result with valid inference/ Quality of Output | Viva voce | Record | Total |
|---|---|---|---|---|---|
| 10 | 15 | 10 | 10 | 5 | 50 |

Submission of Record: Students shall be allowed for the end semester examination only upon submitting the duly certified record.

- ***Endorsement by External Examiner:*** *The external examiner shall endorse the record*

**Course Outcomes (COs)**

At the end of the course students should be able to:

| Course Outcome | | Bloom's Knowledge Level (KL) |
|---|---|---|
| **CO1** | Experiment with concepts of iteration, function, string and list | **K3** |
| **CO2** | **I**dentify the importance of tuples, dictionary traversal, dictionary methods**,** files and operations | **K3** |
| **CO3** | Model graphical representation of data, measures of central tendency and measures of dispersion | **K3** |
| **CO4** | Solve problems based on Binomial distribution, Poisson distribution, sampling and regression analysis | **K3** |
| **CO5** | Make use of various correlation tests and utilize statistical analysis software | **K3** |

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

**CO- PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | √ | √ | √ | | | | | √ | | | √ |
| **CO2** | √ | √ | √ | √ | | | | √ | | | √ |
| **CO3** | √ | √ | √ | √ | | | | √ | | | √ |
| **CO4** | √ | √ | √ | √ | | | | √ | | | √ |
| **CO5** | √ | √ | √ | √ | √ | | | √ | | | √ |

*1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

**Correlation value will be fixed in the course committee meeting*

| Text Books | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| 1 | Probability and Statistics for Engineering and the Sciences | Jay L Devore | Cengage Learning India | 9/e, 2020 |

## Continuous Assessment (25 Marks)

1. **Preparation and Pre-Lab Work (7 Marks)**

   - Pre-Lab Assignments: Assessment of pre-lab assignments or quizzes that test understanding of the upcoming experiment.
   - Understanding of Theory: Evaluation based on students' preparation and understanding of the theoretical background related to the experiments.

2. **Conduct of Experiments (7 Marks)**

   - Procedure and Execution: Adherence to correct procedures, accurate execution of experiments, and following safety protocols.
   - Skill Proficiency: Proficiency in handling equipment, accuracy in observations, and troubleshooting skills during the experiments.
   - Teamwork: Collaboration and participation in group experiments.

3. **Lab Reports and Record Keeping (6 Marks)**

   - Quality of Reports: Clarity, completeness and accuracy of lab reports. Proper documentation of experiments, data analysis and conclusions.
   - Timely Submission: Adhering to deadlines for submitting lab reports/rough record and maintaining a well-organized fair record.

4. **Viva Voce (5 Marks)**

   - Oral Examination: Ability to explain the experiment, results and underlying principles during a viva voce session.

***Final Marks Averaging: The final marks for preparation, conduct of experiments, viva, and record are the average of all the specified experiments in the syllabus.***

## Evaluation Pattern for End Semester Examination (50 Marks)

1. **Procedure/Preliminary Work/Design/Algorithm (10 Marks)**

   - Procedure Understanding and Description: Clarity in explaining the procedure and understanding each step involved.

- Preliminary Work and Planning: Thoroughness in planning and organizing materials/equipment.
- Algorithm Development: Correctness and efficiency of the algorithm related to the experiment.
- Creativity and logic in algorithm or experimental design.

2. **Conduct of Experiment/Execution of Work/Programming (15 Marks)**

- Setup and Execution: Proper setup and accurate execution of the experiment or programming task.

3. **Result with Valid Inference/Quality of Output (10 Marks)**

- Accuracy of Results: Precision and correctness of the obtained results.
- Analysis and Interpretation: Validity of inferences drawn from the experiment or quality of program output.

4. **Viva Voce (10 Marks)**

- Ability to explain the experiment, procedure results and answer related questions
- Proficiency in answering questions related to theoretical and practical aspects of the subject.

5. **Record (5 Marks)**

- Completeness, clarity, and accuracy of the lab record submitted

# SEMESTER – IV

| FOURTH SEMESTER (January-June) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sl. No: | Slot | Course Code | Course Type | Course Category | Course Title (Course Name) | Credit Structure | | | | SS | Total Marks | | Credits | Hrs./ Week |
| | | | | | | L | T | P | R | | CIE | ESE | | |
| 1 | A | 24SJGAMAT401 | BSC | GC | Mathematics for Computer and Information Science -4 | 3 | 0 | 0 | 0 | 4.5 | 40 | 60 | 3 | 3 |
| 2 | B | 24SJPCCST402 | PC | PC | Database Management Systems | 3 | 1 | 0 | 0 | 5 | 40 | 60 | 4 | 4 |
| 3 | C | 24SJPCCST403 | PC | PC | Operating Systems | 3 | 1 | 0 | 0 | 5 | 40 | 60 | 4 | 4 |
| 4 | D | 24SJPBCST404 | PC-PBL | PB | Computer Organization and Architecture | 3 | 0 | 0 | 1 | 5.5 | 60 | 40 | 4 | 4 |
| 5 | E | 24SJPEADT41N | PE | PE | PE-1 | 3 | 0 | 0 | 0 | 4.5 | 40 | 60 | 3 | 3 |
| 6 | G S3/ S4 | 24SJICHUT346 | HMC | IC | Economics for Engineers | 2 | 0 | 0 | 0 | 3 | 50 | 50 | 2 | 2 |
| | | 24SJICHUT347 | | | Engineering Ethics and Sustainable Development | | | | | | | | | |
| 7 | L | 24SJPCADL407 | PCL | PC | Foundations of AI and Data Science Lab | 0 | 0 | 3 | 0 | 1.5 | 50 | 50 | 2 | 3 |
| 8 | Q | 24SJPCCSL408 | PCL | PC | DBMS Lab | 0 | 0 | 3 | 0 | 1.5 | 50 | 50 | 2 | 3 |
| 9 | R/M/ H | | VAC | | Remedial/Minor/Honours Course | 3 | 1 | 0 | 0 | 5 | | | 4* | 4* |
| **Total** | | | | | | | | | | **31 / 36** | | | **24/28*** | **26/30*** |

## SEMESTER S4

## MATHEMATICS FOR COMPUTER AND INFORMATION SCIENCE-4

| | | | |
|---|---|---|---|
| **Course Code** | **24SJGAMAT401** | **CIE Marks** | 40 |
| **Teaching Hours/Week (L: T:P: R)** | 3:0:0:0 | **ESE Marks** | 60 |
| **Credits** | 3 | **Exam Hours** | 2 Hrs. 30 Min. |
| **Prerequisites (if any)** | NIL | **Course Type** | Theory |

**Course Objectives:**

1. To provide a comprehensive understanding of fundamental concepts of graph theory including paths, cycles, trees, graph algorithms, graph coloring and matrix representations, emphasizing their applications across various disciplines.

## SYLLABUS

| Module No. | Syllabus Description | Contact Hours |
|---|---|---|
| 1 | Introduction to Graphs - Basic definition, Application of graphs, finite and infinite graphs, Incidence and Degree, Isolated vertex, Pendant vertex and Null graph. Isomorphism, Sub graphs, Walks, Paths and circuits, Connected graphs, Disconnected graphs and components.<br>**[Text 1: Relevant topics from sections 1.1, 1.2, 1.3, 1.4, 1.5, 2.1, 2.2, 2.4,2.5. Proofs of theorems 2.5, 2.7 are excluded.]** | **9** |
| 2 | Euler graphs, Operations on Graphs, Hamiltonian paths and circuits, Travelling Salesman Problem, Connectivity, Edge connectivity, Vertex connectivity, Directed graphs, Types of directed graphs.<br>**[Text 1: Relevant topics from sections 2.6, 2.7, 2.8, 2.9, 2.10, 4.1, 4.2, 4.5, 9.1, 9.2. Proofs of theorems 4.6, 4.11, 4.12 are excluded.]** | **9** |
| 3 | Trees- properties, Pendant vertices, Distance and centres in a tree, Rooted and binary trees, Counting trees, Spanning trees, Prim's algorithm and Kruskal's algorithm, Dijkstra's shortest path algorithm, Floyd-Warshall shortest path algorithm.<br>**[Text 1: Relevant topics from sections 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.10, 11.5. Proofs of theorems 3.10, 3.16 are excluded.]** | **9** |

| | | |
|---|---|---|
| **4** | Matrix representation of graphs- Adjacency matrix, Incidence Matrix, Circuit Matrix, Path Matrix, Coloring, Chromatic number, Chromatic polynomial, Greedy colouring algorithm.<br><br>**[Text 1: Relevant topics from sections 7.1, 7.3, 7.8, 7.9, 8.1, 8.3. Proofs of theorems 7.4, 7.7, 7.8, 8.2, 8.3, 8.5, 8.6 are excluded.]** | **9** |

**Course Assessment Method**
**(CIE: 40 marks, ESE: 60 marks)**

**Continuous Internal Evaluation Marks (CIE):**

| Attendance | Assignment / Micro project | Internal Examination-1 (Written) | Internal Examination- 2 (Written) | Total |
|---|---|---|---|---|
| 5 | 15 | 10 | 10 | 40 |

**End Semester Examination Marks (ESE)**

*In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions*

| Part A | Part B | Total |
|---|---|---|
| • 2 Questions from each module.<br>• Total of 8 Questions, each carrying 3 marks<br><br>**(8x3 =24marks)** | • Each question carries 9 marks.<br>• Two questions will be given from each module, out of which 1 question should be answered.<br>• Each question can have a maximum of 3 sub divisions.<br><br>**(4x9 = 36 marks)** | **60** |

**Course Outcomes (COs)**

At the end of the course students should be able to:

| | Course Outcome | Bloom's Knowledge Level (KL) |
|---|---|---|
| **CO1** | Understand the fundamental concepts of graph theory such as types of graphs, degree of a vertex, graph isomorphism, connectedness. | **K2** |
| **CO2** | Understand the concepts of Euler graphs, Hamiltonian graphs and connectivity. | **K2** |
| **CO3** | Understand the concept of tree and apply Prim's and Kruskal's algorithms for finding minimum cost spanning tree and Dijkstra's and Floyd-Warshall algorithms for finding shortest paths. | **K3** |
| **CO4** | Illustrate various representations of graphs using matrices and apply vertex coloring in real life problems. | **K3** |

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

**CO-PO Mapping Table:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | - | - | - | - | - | - | - | 2 |
| **CO2** | 3 | 3 | 2 | - | - | - | - | - | - | - | 2 |
| **CO3** | 3 | 3 | 2 | 2 | - | - | - | - | - | - | 2 |
| **CO4** | 3 | 3 | 2 | 2 | - | - | - | - | - | - | 2 |

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

| **Text Books** | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| **1** | Graph Theory with Applications to Engineering and Computer Science | Narsingh Deo | Prentice Hall India Learning Private Limited | 1st edition, 1979 |

| **Reference Books** | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| **1** | Introduction to Graph Theory 2e | Douglas B. West | Pearson Education India | 2nd edition, 2015 |
| **2** | Introduction to Graph Theory | Robin J. Wilson | Longman Group Ltd. | 5th edition, 2010 |
| **3** | Graph Theory with Applications | J.A. Bondy and U.S.R. Murty | Elsevier Science Publishing Co., Inc | 1976 |

| **Video Links (NPTEL, SWAYAM…)** | |
|---|---|
| **Module No.** | **Link ID** |
| **1, 2** | https://onlinecourses.nptel.ac.in/noc22_ma10/preview |
| **3, 4** | https://onlinecourses.nptel.ac.in/noc21_cs48/preview |

# SEMESTER 4

# DATABASE MANAGEMENT SYSTEMS

(Common to CS/CA/AD/CC)

| | | | |
|---|---|---|---|
| **Course Code** | **24SJPCCST402** | **CIE Marks** | 40 |
| **Teaching Hours/Week (L: T:P: R)** | 3:1:0:0 | **ESE Marks** | 60 |
| **Credits** | 4 | **Exam Hours** | 2 Hrs. 30 Min. |
| **Prerequisites (if any)** | 24SJPCCST303 | **Course Type** | Theory |

**Course Objectives:**

1. Equip the students with a comprehensive understanding of fundamental DBMS concepts as well as the principles and applications of NoSQL databases
2. Enable students to design, implement, and manage both relational and NoSQL databases

## SYLLABUS

| Module No. | Syllabus Description | Contact Hours |
|---|---|---|
| 1 | **Introduction to Databases:** - Database System Concepts and Architecture- Data Models, Schemas and Instances, Three-Schema Architecture and Data Independence, Database Languages, Centralized and Client/Server Architectures for DBMSs. **Conceptual Data Modelling and Database Design:**- Data Modelling Using the Entity, Relationship (ER) Model - Entity Types, Entity Sets, Attributes, and Keys, Relationship Types, Relationship Sets, Roles, and Structural Constraints, Weak Entity Types, ER Notations, ER diagrams | **11** |
| 2 | **The Relational Data Model and SQL** - Relational Database Design Using ER-to-Relational Mapping-The Relational Data Model and Relational Database Constraints-Relational Algebra and Relational Calculus - Structured Query Language (SQL)-Data Definition Language, Data Manipulation Language, Aggregation and Grouping, Triggers, views. | **11** |

| | | |
|---|---|---|
| **3** | **Database Design Theory & Normalization** - Functional Dependencies - Basic definition; Normalization- First, Second, and Third normal forms. Transaction Management - Transaction Processing : Introduction, problems and failures in transaction, Desirable properties of transaction, Characterizing schedules based on recoverability and serializability; Concurrency Control with Two-Phase Locking Techniques. | **11** |
| **4** | **Introduction To NoSQL Concepts** - types of NoSQL databases- CAP Theorem- BASE properties- Use Cases and limitations of NoSQL.<br>**SQL architectural Patterns** - Key value Stores, Graph Stores, Column Family stores and Document Stores. | **11** |

**Course Assessment Method**

**(CIE: 40 marks, ESE: 60 marks)**

**Continuous Internal Evaluation Marks (CIE):**

| Attendance | Assignment/ Micro project | Internal Examination-1 (Written) | Internal Examination- 2 (Written) | Total |
|---|---|---|---|---|
| 5 | 15 | 10 | 10 | 40 |

**End Semester Examination Marks (ESE)**

*In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions*

| Part A | Part B | Total |
|---|---|---|
| • 2 Questions from each module.<br>• Total of 8 Questions, each carrying 3 marks<br>**(8x3 =24 marks)** | • Each question carries 9 marks.<br>• Two questions will be given from each module, out of which 1 question should be answered.<br>• Each question can have a maximum of 3 sub divisions.<br>**(4x9 = 36 marks)** | **60** |

## Course Outcomes (COs)

At the end of the course, students should be able to:

| Course Outcome | | Bloom's Knowledge Level (KL) |
|---|---|---|
| **CO1** | Summarize and exemplify the fundamental nature and characteristics of database systems | **K2** |
| **CO2** | Model and design solutions for efficiently representing data using the relational model or non-relational model | **K3** |
| **CO3** | Discuss and compare the aspects of Concurrency Control and Recovery in Database systems | **K3** |
| **CO4** | Construct advanced SQL queries to effectively retrieve, filter, and manipulate data from relational databases. | **K3** |
| **CO5** | Experiment with NoSQL databases in real world applications | **K3** |

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

**CO-PO Mapping Table:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | ✓ | ✓ | ✓ | | | | | | | | ✓ |
| **CO2** | ✓ | ✓ | ✓ | ✓ | | | | ✓ | ✓ | | ✓ |
| **CO3** | ✓ | ✓ | ✓ | ✓ | | | | | | | ✓ |
| **CO4** | ✓ | ✓ | ✓ | ✓ | | | | | | | ✓ |
| **CO5** | ✓ | ✓ | ✓ | ✓ | | | | | | | ✓ |

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*
**Correlation value will be fixed in the course committee meeting*

| Text Books | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| 1 | Fundamentals of Database Systems [Module 1,2,3,4] | Elmasri, Navathe | Pearson | 7/e, |
| 2 | Making the Sense of NoSQL : A guide for Managers and rest of us [Module 4] | Dan McCreary and Ann Kelly | Manning | 2014 |

| Reference Books | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| 1 | A., H. F. Korth and S. Sudarshan, Database System Concepts, | Sliberschatz A., H. F. Korth and S. Sudarshan, Database System Concepts, 6/e, McGraw Hill, 2011. | McGraw Hill, | 7/e, 2011 |
| 2 | Beginning Database Design Solutions | Rod Stephens | Wiley | 2/e, 2023 |
| 3 | NoSQL Distilled | Pramod J. Sadalage, Martin Fowler | Addison-Wesley | 1/e, 2012 |
| 4 | NoSQL Data Models: Trends and Challenges (Computer Engineering: Databases and Big Data), | Olivier Pivert | Wiley | 2018 |

| Video Links (NPTEL, SWAYAM…) | |
|---|---|
| **Module No.** | **Link ID** |
| **1** | https://onlinecourses.nptel.ac.in/noc21_cs04/preview |
| **2** | https://onlinecourses.nptel.ac.in/noc21_cs04/preview |
| **3** | https://onlinecourses.nptel.ac.in/noc21_cs04/preview |
| **4** | https://archive.nptel.ac.in/courses/106/104/106104135/ |

# SEMESTER 4

# OPERATING SYSTEMS

(Common to CS/CA/AD/CC)

| | | | |
|---|---|---|---|
| **Course Code** | **24SJPCCST403** | **CIE Marks** | 40 |
| **Teaching Hours/Week (L: T:P: R)** | 3:1:0:0 | **ESE Marks** | 60 |
| **Credits** | 4 | **Exam Hours** | 2 Hrs. 30 Min. |
| **Prerequisites (if any)** | None | **Course Type** | Theory |

**Course Objectives:**

1. To introduce the structure of a typical operating system and its core functionalities
2. To impart to the students, a practical understanding of OS implementation nuances based on the Linux operating system

## SYLLABUS

| Module No. | Syllabus Description | Contact Hours |
|---|---|---|
| 1 | **Introduction to Operating Systems** (Book 1 Ch 2 introductory part), Operating System Services (Book 3 Ch 2) Overview of Operating Systems and Kernels, Linux Versus Classic Unix Kernels (Book 2 Ch 1)<br>**Process concepts:** Process Creation, Process States, Data Structures, Process API (Book 1 Ch 4, 5), Sharing processor among processes - user and kernel modes, context switching (Book 1 Ch 6), System boot sequence (Book 3 Ch 2)<br>***Case study**: Linux kernel process management (Book 2, Ch 3)*<br>**Threads and Concurrency**: Concept of a thread, Multithreading benefits, Multithreading models (Book 3 Ch 4)<br>***Case study:** The Linux Implementation of Threads (Book 2, Ch 3)*<br>**Process scheduling**: Concepts and basic algorithms (Book 1 Ch 7), The Multilevel Feedback Queue: Basic Rules (Book 1 Ch 8)<br>***Case study:** The Linux Completely Fair Scheduler (CFS) (Book 1 Ch 9, Implementation with RB trees not required), The Linux Scheduling Implementation, Preemption and Context Switching (Book 2, Ch 4)* | 11 |

| | | |
|---|---|---|
| **2** | **Concurrency and Synchronization** - Basic principles (Book 3 Sections 6.1, 6.2), Mechanisms - Locks: The Basic Idea, Building Spin Locks with Test-And-Set, Compare and Swap, Using Queues: Sleeping Instead of Spinning (Book 1 Ch 28), Semaphores - Definition, Binary Semaphores, The Producer/Consumer (Bounded Buffer) Problem and its solution using semaphores, Reader-Writer Locks (Book 1 Ch 31)<br>***Case study**: Linux Kernel Synchronization Methods - Spin Locks, Semaphores, Mutexes (Book 2 Ch 10)*<br>**Concurrency:** Deadlock and Starvation - Deadlock Characterization, Deadlock Prevention and Avoidance, Deadlock Detection and recovery (Book 3 Ch 8), Dining Philosophers Problem and its solution (Book 1 Ch 31) | **11** |
| **3** | **Memory management** - Address Space, Memory API, Address Translation - An Example, Dynamic (Hardware-based) Relocation, Segmentation: Generalized Base/Bounds, Address translation in segmentation, Support for Sharing (Book 1 Ch 13 to 16)<br>**Virtual memory** - Paging: Introduction, page tables and hardware support, TLBs, Example: Accessing an Array, - TLB hits and misses, Handling TLB misses, TLB structure, Reducing the page table size (Book 1 Ch 18 to 20)<br>**Going beyond physical memory** - Swap space, page fault and its control flow, page replacement policies, Thrashing (Book 1 Ch 21, 22) | **11** |
| **4** | **I/O system:** Modern System architecture, Programmed I/O, Interrupts, Device interaction methods, The Device Driver (Book 1 Ch 36),<br>**Hard disk:** Geometry (Book 1 Ch 37), disk scheduling (Book 3 Section 11.2)<br>***Case study**: Linux I/O schedulers - Elevator, Complete Fair Queuing (Book 2 Ch 14)*<br>**Files and Directories**: The File System Interface - File descriptor, reading and writing files (sequential and random access), Creating, reading and deleting directories, Permission bits and Access Control Lists, Mounting a file system (Book 1 Ch 39)<br>**File Organization**: The Inode, The Multi-Level Index (Book 1 Ch 40)<br>***Case study:** VFS Objects and Their Data Structures - The Inode Object, Inode Operations (Book 2 Ch 13)* | **11** |

**Course Assessment Method**
**(CIE: 40 marks, ESE: 60 marks)**

**Continuous Internal Evaluation Marks (CIE):**

| Attendance | Assignment/ Micro project | Internal Examination-1 (Written) | Internal Examination- 2 (Written) | Total |
|---|---|---|---|---|
| 5 | 15 | 10 | 10 | 40 |

**End Semester Examination Marks (ESE)**

*In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions*

| Part A | Part B | Total |
|---|---|---|
| • 2 Questions from each module.<br>• Total of 8 Questions, each carrying 3 marks<br>**(8x3 =24 marks)** | • Each question carries 9 marks.<br>• Two questions will be given from each module, out of which 1 question should be answered.<br>• Each question can have a maximum of 3 sub- divisions.<br>**(4x9 = 36 marks)** | **60** |

**Course Outcomes (COs)**

At the end of the course students should be able to:

| | Course Outcome | Bloom's Knowledge Level (KL) |
|---|---|---|
| **CO1** | Apply the concepts of process management and process scheduling mechanisms employed in operating systems. | **K3** |
| **CO2** | Choose various process synchronization mechanisms employed in operating systems. | **K3** |
| **CO3** | Use deadlock prevention and avoidance mechanisms in operating systems. | **K3** |
| **CO4** | Select various memory management techniques in operating systems. | **K3** |
| **CO5** | Understand the storage management in operating systems. | **K2** |

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

**CO-PO Mapping Table:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | ✓ | ✓ | ✓ | | | | | | | | ✓ |
| **CO2** | ✓ | ✓ | ✓ | | | | | | | | ✓ |
| **CO3** | ✓ | ✓ | ✓ | | | | | | | | ✓ |
| **CO4** | ✓ | ✓ | ✓ | | | | | | | | ✓ |
| **CO5** | ✓ | ✓ | ✓ | | | | | | | | ✓ |

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*
**Correlation value will be fixed in the course committee meeting*

| **Text Books** | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| 1 | Operating Systems: Three Easy Pieces | Andrea Arpaci-Dusseau, Remzi Arpaci-Dusseau | CreateSpace | 1/e, 2018 |
| 2 | Linux Kernel Development | Robert Love | Pearson | 3/e, 2018 |
| 3 | Operating System Concepts | Abraham Silberschatz, Peter B. Galvin, Greg Gagne | Wiley | 10/e, 2018 |

| **Reference Books** | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| 1 | Modern Operating Systems | Andrew S. Tanenbaum Herbert Bos | Pearson | 5/e, 2012 |
| 2 | The Design of the UNIX Operating System | Maurice J. Bach | Prentice Hall of India | 1/e, 1994 |
| 3 | The Little Book of Semaphores | Allen B. Downey | Green Tea Press | 1/e, 2016 |

| **Video Links (NPTEL, SWAYAM…)** | |
|---|---|
| **No.** | **Link ID** |
| 1 | https://archive.nptel.ac.in/courses/106/105/106105214/ |
| 2 | https://www.youtube.com/playlist?list=PLDW872573QAb4bj0URobvQTD41IV6gRkx |

# SEMESTER 4

## COMPUTER ORGANIZATION AND ARCHITECTURE

(Common to CS/CA/AD/CC)

| Course Code | 24SJPBCST404 | CIE Marks | 60 |
|---|---|---|---|
| Teaching Hours/Week (L: T:P: R) | 3:0:0:1 | ESE Marks | 40 |
| Credits | 4 | Exam Hours | 2 Hrs. 30 Min. |
| Prerequisites (if any) | 24SJGAEST305 | Course Type | Theory |

**Course Objectives**

1. Introduce principles of computer organization and the basic architectural concepts.
2. Introduce the concepts of Processing units, pipelining, memory systems, and I/O systems.

## SYLLABUS

| Module No. | Syllabus Description | Contact Hours |
|---|---|---|
| 1 | **Basic Structure of computers: –** Functional units - Basic operational concepts; Memory map; Endianness. **Programming concepts -** Program flow, Branching, Conditional statements, Loops, Arrays, Function calls; **Machine language -** Instructions, addressing modes, Stored program concept. | **12** |
| 2 | **Basic Processing Units** -Fundamental concepts, instruction cycle, execution of a complete instruction, single bus and multiple bus organization; **Pipelining -** Pipelined Processor - Pipelined Data Path, Pipelined Control: Hazards, Solving Data/Control Hazards, Performance Analysis. | **12** |
| 3 | **Memory Systems:** Introduction; Internal organization of memory chips, Memory system consideration. **Caches** - Basic concepts, Cache mapping, Cache replacement, Performance Considerations. | **10** |
| 4 | **Input / Output** -Accessing of I/O devices- I/O Modules; Programmed I/O, Interrupt Driven I/O; Interrupts, Interrupt hardware External Devices; Direct Memory Access;. | **10** |

**Suggestion on Project Topics**

Use simulators such as Ripes (https://github.com/mortbopet/Ripes) / GEM5 (https://www.gem5.org/) implement components of computer systems such as Various Cache organization and study the effect, Solutions to hazards, TLBs.

**Course Assessment Method**
**(CIE:60 marks, ESE: 40 marks)**

**Continuous Internal Evaluation Marks (CIE):**

| Attendance | Project | Internal Ex-1 | Internal Ex-2 | Total |
|---|---|---|---|---|
| 5 | 30 | 12.5 | 12.5 | 60 |

**End Semester Examination Marks (ESE)**

*In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions*

| Part A | Part B | Total |
|---|---|---|
| • 2 Questions from each module.<br>• Total of 8 Questions, each carrying 2 marks<br>**(8x2 =16 marks)** | 2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 subdivisions. Each question carries 6 marks.<br>**(4x6 = 24 marks)** | **40** |

**Course Outcomes (COs)**

At the end of the course students should be able to:

| | Course Outcome | Bloom's Knowledge Level (KL) |
|---|---|---|
| **CO1** | Identify the basic structure and functional units of a digital computer. | **K2** |
| **CO2** | Understand architecture concepts, including processing units, instruction cycles, bus organizations, and pipelining for performance optimization. | **K3** |
| **CO3** | Utilize the memory organization in modern computer systems. | **K3** |
| **CO4** | Experiment with the I/O organization of a digital computer. | **K3** |

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

**CO-PO Mapping Table:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | ✓ | ✓ | ✓ | | | | | | | | ✓ |
| **CO2** | ✓ | ✓ | ✓ | ✓ | | | | | | | ✓ |
| **CO3** | ✓ | ✓ | ✓ | ✓ | | | | | | | ✓ |
| **CO4** | ✓ | ✓ | ✓ | ✓ | | | | | | | ✓ |

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*
**Correlation value will be fixed in the course committee meeting*

| **Text Books** | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| **1** | Computer Organization | Hamacher C., Z. Vranesic and S. Zaky | McGraw Hil | 5/e, 2011 |
| **2** | Computer Organization and Architecture Designing for Performance | William Stallings | Pearson | 9/e, 2013 |

| **Reference Books** | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| **1** | Computer Organization and Design: The Hardware/ Software Interface: RISC-V Edition | David A. Patterson John L. Hennessy | Morgan Kaufaman | 1/e,2018 |
| **2** | Computer Organization and Embedded Systems | Carl Hamacher, Zvonko Vranesic, Safwat Zaky, Naraig Manjikian | McGraw Hil | 6/e, 2012 |
| **3** | Modern Computer Architecture and Organization | Jim Ledin | Packt Publishing | 1/e,2020 |

| **Video Links (NPTEL, SWAYAM…)** | |
|---|---|
| **No.** | **Link ID** |
| 1 | https://archive.nptel.ac.in/courses/106/105/106105163/ |
| 2 | https://archive.nptel.ac.in/courses/106/106/106106166/ |

**PBL Course Elements**

| L: Lecture (3 Hrs.) | R: Project (1 Hr.), 2 Faculty Members | | |
|---|---|---|---|
| | **Tutorial** | **Practical** | **Presentation** |
| Lecture delivery | Project identification | Simulation/ Laboratory Work/ Workshops | Presentation (Progress and Final Presentations) |
| Group discussion | Project Analysis | Data Collection | Evaluation |
| Question answer Sessions/ Brainstorming Sessions | Analytical thinking and self-learning | Testing | Project Milestone Reviews, Feedback, Project reformation (If required) |
| Guest Speakers (Industry Experts) | Case Study/ Field Survey Report | Prototyping | Poster Presentation/ Video Presentation: Students present their results in a 2 to 5 minutes video |

**Assessment and Evaluation for Project Activity**

| Sl. No | Evaluation for | Allotted Marks |
|---|---|---|
| 1 | Project Planning and Proposal | 5 |
| 2 | Contribution in Progress Presentations and Question Answer Sessions | 4 |
| 3 | Involvement in the project work and Team Work | 3 |
| 4 | Execution and Implementation | 10 |
| 5 | Final Presentations | 5 |
| 6 | Project Quality, Innovation and Creativity | 3 |
| **Total** | | **30** |

1. **Project Planning and Proposal (5 Marks)**
   - Clarity and feasibility of the project plan
   - Research and background understanding
   - Defined objectives and methodology
2. **Contribution in Progress Presentation and Question Answer Sessions (4 Marks)**
   - Individual contribution to the presentation
   - Effectiveness in answering questions and handling feedback
3. **Involvement in the Project Work and Team Work (3 Marks)**
   - Active participation and individual contribution
   - Teamwork and collaboration

4. **Execution and Implementation (10 Marks)**
    - Adherence to the project timeline and milestones
    - Application of theoretical knowledge and problem-solving
    - Final Result
5. **Final Presentation (5 Marks)**
    - Quality and clarity of the overall presentation
    - Individual contribution to the presentation
    - Effectiveness in answering questions
6. **Project Quality, Innovation, and Creativity (3 Marks)**
    - Overall quality and technical excellence of the project
    - Innovation and originality in the project
    - Creativity in solutions and approaches

# SEMESTER 4

## ENGINEERING ETHICS AND SUSTAINABLE DEVELOPMENT

| | | | |
|---|---|---|---|
| **Course Code** | **24SJICHUT347** | **CIE Marks** | 50 |
| **Teaching Hours/Week (L: T:P: R)** | 2:0:0:0 | **ESE Marks** | 50 |
| **Credits** | 2 | **Exam Hours** | 2 Hrs. 30 Min. |
| **Prerequisites (if any)** | None | **Course Type** | Theory |

**Course Objectives:**

1. Equip with the knowledge and skills to make ethical decisions and implement gender-sensitive practices in their professional lives.
2. Develop a holistic and comprehensive interdisciplinary approach to understanding engineering ethics principles from a perspective of environment protection and sustainable development.
3. Develop the ability to find strategies for implementing sustainable engineering solutions.

## SYLLABUS

| Module No. | Syllabus Description | Contact Hours |
|---|---|---|
| 1 | **Fundamentals of ethics** - Personal vs. professional ethics, Civic Virtue, Respect for others, **Profession and Professionalism,** Ingenuity, diligence and responsibility, Integrity in design, development, and research domains, Plagiarism, a balanced outlook on law - challenges - case studies, **Technology and digital revolution**-Data, information, and knowledge, Cybertrust and cybersecurity, Data collection & management, **High technologies: connecting people and places**-accessibility and social impacts, **Managing conflict**, Collective bargaining, **Confidentiality**, Role of confidentiality in moral integrity, **Codes of Ethics**.<br>**Basic concepts in Gender Studies** - sex, gender, sexuality, gender spectrum: beyond the binary, gender identity, gender expression, gender stereotypes, **Gender disparity and discrimination in education**, | 6 |

| | | |
|---|---|---|
| | employment and everyday life, History of women in Science & Technology, Gendered technologies & innovations**, Ethical values and practices in connection with gender** - equity, diversity & gender justice, **Gender policy and women/transgender empowerment initiatives.** | |
| **2** | **Introduction to Environmental Ethics:** Definition, importance and historical development of environmental ethics, key philosophical theories (anthropocentrism, biocentrism, ecocentrism). **Sustainable Engineering Principles:** Definition and scope, triple bottom line (economic, social and environmental sustainability), life cycle analysis and sustainability metrics. **Ecosystems and Biodiversity:** Basics of ecosystems and their functions, Importance of biodiversity and its conservation, Human impact on ecosystems and biodiversity loss, An overview of various ecosystems in Kerala/India, and its significance. **Landscape and Urban Ecology:** Principles of landscape ecology, Urbanization and its environmental impact, Sustainable urban planning and green infrastructure. | **6** |
| **3** | **Hydrology and Water Management:** Basics of hydrology and water cycle, Water scarcity and pollution issues, Sustainable water management practices, Environmental flow, disruptions and disasters. **Zero Waste Concepts and Practices:** Definition of zero waste and its principles, Strategies for waste reduction, reuse, reduce and recycling, Case studies of successful zero waste initiatives. **Circular Economy and Degrowth:** Introduction to the circular economy model, Differences between linear and circular economies, degrowth principles, Strategies for implementing circular economy practices and degrowth principles in engineering. **Mobility and Sustainable Transportation:** Impacts of transportation on the environment and climate, Basic tenets of a Sustainable Transportation design, Sustainable urban mobility solutions, Integrated mobility systems, E-Mobility, Existing and upcoming models of sustainable mobility solutions. | **6** |

| | | |
|---|---|---|
| 4 | **Renewable Energy and Sustainable Technologies:** Overview of renewable energy sources (solar, wind, hydro, biomass), Sustainable technologies in energy production and consumption, Challenges and opportunities in renewable energy adoption. **Climate Change and Engineering Solutions:** Basics of climate change science, Impact of climate change on natural and human systems, Kerala/India and the Climate crisis, Engineering solutions to mitigate, adapt and build resilience to climate change. **Environmental Policies and Regulations:** Overview of key environmental policies and regulations (national and international), Role of engineers in policy implementation and compliance, Ethical considerations in environmental policy-making. **Case Studies and Future Directions:** Analysis of real- world case studies, Emerging trends and future directions in environmental ethics and sustainability, Discussion on the role of engineers in promoting a sustainable future. | 6 |

**Course Assessment Method**

**(CIE: 50 marks, ESE: 50)**

**Continuous Internal Evaluation Marks (CIE):**

Continuous internal evaluation will be based on individual and group activities undertaken throughout the course and the portfolio created documenting their work and learning. The portfolio will include reflections, project reports, case studies, and all other relevant materials.

a. The students should be grouped into groups of size 4 to 6 at the beginning of the semester. These groups can be the same ones they have formed in the previous semester.
b. Activities are to be distributed between 2 class hours and 3 Self-study hours.
c. The portfolio and reflective journal should be carried forward and displayed during the 7th Semester Seminar course as a part of the experience sharing regarding the skills developed through various courses.

| Sl. No. | Item | Particulars | Group/ Individual (G/I) | Marks |
|---|---|---|---|---|
| 1 | Reflective Journal | Weekly entries reflecting on what was learned, personal insights, and how it can be applied to local contexts. | I | 5 |
| 2 | Micro project<br><br>(Detailed documentation of the project, including methodologies, findings, and reflections) | 1 a) Perform an Engineering Ethics Case Study analysis and prepare a report<br><br>1 b) Conduct a literature survey on 'Code of Ethics for Engineers' and prepare a sample code of ethics | G | 8 |
| | | 2. Listen to a TED talk on a Gender-related topic, do a literature survey on that topic and make a report citing the relevant papers with a specific analysis of the Kerala context | G | 5 |
| | | 3. Undertake a project study based on the concepts of sustainable development* - Module II, Module III & Module IV | G | 12 |
| 3 | Activities | 2. One activity* each from Module II, Module III & Module IV | G | 15 |
| 4 | Final Presentation | A comprehensive presentation summarising the key takeaways from the course, personal reflections, and proposed future actions based on the learnings. | G | 5 |
| | | Total Marks | | **50** |

*Can be taken from the given sample activities/projects

**Evaluation Criteria:**

- **Depth of Analysis**: Quality and depth of reflections and analysis in project reports and case studies.
- **Application of Concepts**: Ability to apply course concepts to real-world problems and local contexts.
- **Creativity**: Innovative approaches and creative solutions proposed in projects and reflections.
- **Presentation Skills**: Clarity, coherence, and professionalism in the final presentation.

**Course Outcomes (COs)**

At the end of the course students should be able to:

| Course Outcome | | Bloom's Knowledge Level (KL) |
|---|---|---|
| **CO1** | Develop the ability to apply the principles of engineering ethics in their professional life. | **K3** |
| **CO2** | Develop the ability to exercise gender-sensitive practices in their professional lives | **K4** |
| **CO3** | Develop the ability to explore contemporary environmental issues and sustainable practices. | **K5** |
| **CO4** | Develop the ability to analyse the role of engineers in promoting sustainability and climate resilience. | **K4** |
| **CO5** | Develop interest and skills in addressing pertinent environmental and climate-related challenges through a sustainable engineering approach. | **K3** |

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

**CO-PO Mapping Table:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | | | | | | ✓ | ✓ | ✓ | ✓ | | ✓ |
| **CO2** | | ✓ | | | | ✓ | ✓ | ✓ | ✓ | | ✓ |
| **CO3** | | | | | | ✓ | ✓ | ✓ | ✓ | | ✓ |
| **CO4** | | ✓ | | | | ✓ | ✓ | ✓ | ✓ | | ✓ |
| **CO5** | | | | | | ✓ | ✓ | ✓ | ✓ | | ✓ |

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*
**Correlation value will be fixed in the course committee meeting*

| Reference Books | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| **1** | Ethics in Engineering Practice and Research | Caroline Whitbeck | Cambridge University Press & Assessment | 2nd edition & August 2011 |
| **2** | Virtue Ethics and Professional Roles | Justin Oakley | Cambridge University Press & Assessment | ovember 2006 |
| **3** | Sustainability Science | Bert J. M. de Vries | Cambridge University Press & Assessment | 2nd edition & December 2023 |
| **4** | Sustainable Engineering Principles and Practice | Bhavik R. Bakshi, | Cambridge University Press & Assessmen | 2019 |
| **5** | Engineering Ethics | M Govindarajan, S Natarajan and V S Senthil Kumar | PHI Learning Private Ltd, New Delhi | 2012 |
| **6** | Professional ethics and human values | RS Naagarazan | New age international (P) limited New Delhi | 2006. |
| **7** | Ethics in Engineering | Mike W Martin and Roland Schinzinger, | Tata McGraw Hill Publishing Company Pvt Ltd, New Delhi | 4" edition, 2014 |

**Suggested Activities/Projects:**

**Module-II**

- Write a reflection on a local environmental issue (e.g., plastic waste in Kerala backwaters or oceans) from different ethical perspectives (anthropocentric, biocentric, ecocentric).
- Write a life cycle analysis report of a common product used in Kerala (e.g., a coconut, bamboo or rubber-based product) and present findings on its sustainability.
- Create a sustainability report for a local business, assessing its environmental, social, and economic impacts
- Presentation on biodiversity in a nearby area (e.g., a local park, a wetland, mangroves, college campus etc) and propose conservation strategies to protect it.
- Develop a conservation plan for an endangered species found in Kerala.
- Analyze the green spaces in a local urban area and propose a plan to enhance urban ecology using native plants and sustainable design.
- Create a model of a sustainable urban landscape for a chosen locality in Kerala.

**Module-III**

- Study a local water body (e.g., a river or lake) for signs of pollution or natural flow disruption and suggest sustainable management and restoration practices.
- Analyse the effectiveness of water management in the college campus and propose improvements - calculate the water footprint, how to reduce the footprint, how to increase supply through rainwater harvesting, and how to decrease the supply-demand ratio
- Implement a zero-waste initiative on the college campus for one week and document the challenges and outcomes.
- Develop a waste audit report for the campus. Suggest a plan for a zero-waste approach.
- Create a circular economy model for a common product used in Kerala (e.g., coconut oil, cloth etc).
- Design a product or service based on circular economy and degrowth principles and present a business plan.
- Develop a plan to improve pedestrian and cycling infrastructure in a chosen locality in Kerala

**Module-IV**

- Evaluate the potential for installing solar panels on the college campus including cost- benefit analysis and feasibility study.
- Analyse the energy consumption patterns of the college campus and propose sustainable alternatives to reduce consumption - What gadgets are being used? How can we reduce demand using energy- saving gadgets?
- Analyse a local infrastructure project for its climate resilience and suggest improvements.
- Analyse a specific environmental regulation in India (e.g., Coastal Regulation Zone) and its impact on local communities and ecosystems.
- Research and present a case study of a successful sustainable engineering project in Kerala/India (e.g., sustainable building design, water management project, infrastructure project).
- Research and present a case study of an unsustainable engineering project in Kerala/India highlighting design and implementation faults and possible corrections/alternatives (e.g., a housing complex with water logging, a water management project causing frequent floods, infrastructure project that affects surrounding landscapes or ecosystems).

# SEMESTER S4

## FOUNDATIONS OF AI AND DATA SCIENCE LAB

| | | | |
|---|---|---|---|
| **Course Code** | **24SJPCADL407** | **CIE Marks** | 50 |
| **Teaching Hours/Week (L: T:P: R)** | 0:0:3:0 | **ESE Marks** | 50 |
| **Credits** | 2 | **Exam Hours** | 2 Hrs. 30 Min. |
| **Prerequisites (if any)** | PCAIT302, PBADT304 | **Course Type** | Lab |

**Course Objectives**

1. To get hands-on experience in AI and data science using Python programming.
2. To develop an expert system for knowledge representation and reasoning.

*** Mandatory**

| Expt. No. | Experiments |
|---|---|
| 1 | Implement basic search strategies (BFS, DFS) for selected AI applications.* |
| 2 | Implement informed search (A*) algorithms for routing problem.* |
| 3 | Implement backtracking algorithms for Constraint Satisfaction Problem.* |
| 4 | Implementation of Alpha-Beta pruning to find optimal solution for a given problem.* |
| 5 | Implement a program to find a solution by using the local optima (Hill Climbing) algorithm.* |
| 6 | Implement propositional logic inferences for AI tasks.* |
| 7 | Implementation of Knowledge representation schemes.* |
| 8 | Write a program to find Correlation between different features of a dataset in csv format.* |
| 9 | Write a program to implement feature reduction using PCA. Calculate the covariance between features to find the optimal number of PCA components.* |
| 10 | Implement Apriori algorithm in python to find relationships among numerous items in a dataset. |
| 11 | Implement FP-Growth algorithm in python to find frequent patterns in large database efficiently. |
| 12 | Implement Clustering algorithm to categorize the data.* |

**Course Assessment Method**

**(CIE: 50 marks, ESE: 50 marks)**

**Continuous Internal Evaluation Marks (CIE):**

| Attendance | Preparation/Pre-Lab Work experiments, Viva and Timely completion of Lab Reports / Record (Continuous Assessment) | Internal Examination | Total |
|---|---|---|---|
| 5 | 25 | 20 | 50 |

**End Semester Examination Marks (ESE):**

| Procedure/ Preparatory work/Design/ Algorithm | Conduct of experiment/ Execution of work/ troubleshooting/ Programming | Result with valid inference/ Quality of Output | Viva voce | Record | Total |
|---|---|---|---|---|---|
| 10 | 15 | 10 | 10 | 5 | 50 |

- ***Submission of Record: Students shall be allowed for the end semester examination only upon submitting the duly certified record.***
- ***Endorsement by External Examiner:*** *The external examiner shall endorse the record*

**Course Outcomes (COs)**

At the end of the course students should be able to:

| Course Outcome | | Bloom's Knowledge Level (KL) |
|---|---|---|
| **CO1** | Implement basic searching strategies, mathematical optimization methods and constraint satisfaction problems. | **K3** |
| **CO2** | Develop an expert system by using appropriate tools and techniques. | **K3** |
| **CO3** | Apply different methods (like Correlation and Covariance) to determine the dependence between features in the dataset and apply dimensionality reduction techniques. | **K3** |
| **CO4** | Apply various association rule mining and clustering techniques. | **K3** |

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

**CO- PO Mapping (Mapping of Course Outcomes with Program Outcomes)**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 3 | 2 | | | | | | 3 |
| **CO2** | 3 | 3 | 3 | 3 | 2 | | | | | | 3 |
| **CO3** | 3 | 3 | 3 | 2 | 2 | | | | | | 3 |
| **CO4** | 3 | 3 | 3 | 2 | 2 | | | | | | 3 |

*1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

| **Text Books** | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| **1** | Hands–On Machine Learning with Scikit–Learn and TensorFlow | Aurelien Geron | O'Reilly | 2/e, 2019 |
| **2** | Data science and big data analytics, discovering, analyzing, visualizing, and presenting data | David dietrich | John Wiley and sons | 1/e, 2014 |
| **3** | Artificial Intelligence and Intelligent Systems | Padhy, N.P. | Oxford University Press | 1/e, 2005 |

| **Reference Books** | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| **1** | Artificial Intelligence: A Modern Approach | Stuart J. Russell, Peter Norvig | Pearson Education. | 2/e,2003 |
| **2** | Knowledge Representation and Reasoning | Brachman, R. and Levesque, H. | Morgan Kaufmann | 1/e, 2004 |

| **Video Links (NPTEL, SWAYAM…)** | |
|---|---|
| **Module No.** | **Link ID** |
| **1** | https://onlinecourses.nptel.ac.in/noc22_cs32/preview |
| **2** | https://onlinecourses.nptel.ac.in/noc21_ge20/preview |
| **3** | https://www.coursera.org/learn/data-analysis-with-python |

## Continuous Assessment (25 Marks)

1. **Preparation and Pre-Lab Work (7 Marks)**
   - Pre-Lab Assignments: Assessment of pre-lab assignments or quizzes that test understanding of the upcoming experiment.
   - Understanding of Theory: Evaluation based on students' preparation and understanding of the theoretical background related to the experiments.

2. **Conduct of Experiments (7 Marks)**
   - Procedure and Execution: Adherence to correct procedures, accurate execution of experiments, and following safety protocols.
   - Skill Proficiency: Proficiency in handling equipment, accuracy in observations, and troubleshooting skills during the experiments.
   - Teamwork: Collaboration and participation in group experiments.

3. **Lab Reports and Record Keeping (6 Marks)**
   - Quality of Reports: Clarity, completeness and accuracy of lab reports. Proper documentation of experiments, data analysis and conclusions.
   - Timely Submission: Adhering to deadlines for submitting lab reports/rough record and maintaining a well-organized fair record.

4. **Viva Voce (5 Marks)**
   - Oral Examination: Ability to explain the experiment, results and underlying principles during a viva voce session.

***Final Marks Averaging: The final marks for preparation, conduct of experiments, viva, and record are the average of all the specified experiments in the syllabus.***

## Evaluation Pattern for End Semester Examination (50 Marks)

1. **Procedure/Preliminary Work/Design/Algorithm (10 Marks)**
   - Procedure Understanding and Description: Clarity in explaining the procedure and understanding each step involved.
   - Preliminary Work and Planning: Thoroughness in planning and organizing materials/equipment.
   - Algorithm Development: Correctness and efficiency of the algorithm related to the experiment.
   - Creativity and logic in algorithm or experimental design.
2. **Conduct of Experiment/Execution of Work/Programming (15 Marks)**
   - Setup and Execution: Proper setup and accurate execution of the experiment or programming task.
3. **Result with Valid Inference/Quality of Output (10 Marks)**
   - Accuracy of Results: Precision and correctness of the obtained results.
   - Analysis and Interpretation: Validity of inferences drawn from the experiment or quality of program output.
4. **Viva Voce (10 Marks)**
   - Ability to explain the experiment, procedure results and answer related questions
   - Proficiency in answering questions related to theoretical and practical aspects of the subject.
5. **Record (5 Marks)**
   - Completeness, clarity, and accuracy of the lab record submitted

# SEMESTER 4

## DBMS LAB

(Common to CS/CA/AD//CC)

| | | | |
|---|---|---|---|
| **Course Code** | **24SJPCCSL408** | **CIE Marks** | 50 |
| **Teaching Hours/Week (L: T:P: R)** | 0:0:3:0 | **ESE Marks** | 50 |
| **Credits** | 2 | **Exam Hours** | 2 Hrs. 30 Min. |
| **Prerequisites (if any)** | None | **Course Type** | Lab |

**Course Objectives:**

1. To equip students with comprehensive skills in SQL, PL/SQL, and NoSQL databases.
2. To enable the learner to proficiently design, implement, and manage relational and non- relational databases to meet diverse data management needs

| Expt. No. | Experiments |
|---|---|
| 1 | Design a database schema for an application with ER diagram from a problem description. |
| 2 | Creation of database schema - DDL (create tables, set constraints, enforce relationships, create indices, delete and modify tables) |
| 3 | Database initialization - Data insert, Data import to a database (bulk import using UI and SQL Commands). |
| 4 | Practice SQL commands for DML (insertion, updating, altering, deletion of data, and viewing/querying records based on condition in databases). |
| 5 | Implementation of various aggregate functions, Order By, Group By & Having clause in SQL. |
| 6 | Implementation of set operators nested queries, and join queries. |
| 7 | Practice of SQL TCL DCL commands like Rollback, Commit, Save point, Practice of SQL DCL commands for granting and revoking user privileges. |
| 8 | Practice of SQL commands for creation of views. |
| 9 | Creation of Procedures, Triggers and Functions. |
| 10 | Creation of Packages and cursors. |
| 11 | Perform basic CRUD (Create, Read, Update, Delete) operations on a Cassandra table. |
| 12 | Write and execute CQL queries to retrieve specific data from Cassandra tables |
| 13 | Create a simple application using Mongodb with any front-end Tool. |

** The problem must be designed to convey the difference of NoSQL from SQL databases.

**Course Assessment Method**
**(CIE: 50 marks, ESE: 50 marks)**

**Continuous Internal Evaluation Marks (CIE):**

| Attendance | Preparation/Pre-Lab Work experiments, Viva and Timely completion of Lab Reports / Record (Continuous Assessment) | Internal Examination | Total |
|---|---|---|---|
| 5 | 25 | 20 | 50 |

**End Semester Examination Marks (ESE):**

| Procedure/ Preparatory work/Design/ Algorithm | Conduct of experiment/ Execution of work/ troubleshooting/ Programming | Result with valid inference/ Quality of Output | Viva voce | Record | Total |
|---|---|---|---|---|---|
| 10 | 15 | 10 | 10 | 5 | 50 |

- ***Submission of Record: Students shall be allowed for the end semester examination only upon submitting the duly certified record.***
- ***Endorsement by External Examiner:*** *The external examiner shall endorse the record*

**Course Outcomes (COs)**

At the end of the course students should be able to:

| | Course Outcome | Bloom's Knowledge Level (KL) |
|---|---|---|
| **CO1** | Develop database schema for a given real world problem-domain using standard design and modeling approaches | **K3** |
| **CO2** | Construct queries using SQL for database creation, interaction, modification, and updation. | **K3** |
| **CO3** | Plan and implement triggers and cursors, procedures, functions, and control structures using PL/SQL | **K3** |
| **CO4** | Perform CRUD operations in NoSQL Databases | **K3** |
| **CO5** | Design database applications using front-end tools and back-end DBMS | **K5** |

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

## CO- PO Mapping (Mapping of Course Outcomes with Program Outcomes)

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | ✓ | ✓ | ✓ | ✓ | | | | | ✓ | | ✓ |
| CO2 | ✓ | ✓ | ✓ | ✓ | | | | | ✓ | | ✓ |
| CO3 | ✓ | ✓ | ✓ | ✓ | | | | | ✓ | | ✓ |
| CO4 | ✓ | ✓ | ✓ | ✓ | ✓ | | | | ✓ | | ✓ |
| CO5 | ✓ | ✓ | ✓ | ✓ | ✓ | | | | ✓ | ✓ | ✓ |

*1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*
**Correlation value will be fixed in the course committee meeting*

| Text Books | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| 1 | Fundamentals of Database Systems | Elmasri, Navathe | Pearson | 7/e, 2017 |
| 2 | Professional NoSQL | Shashank Tiwari | Wiley | 1/e, 2011 |

| Reference Books | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| 1 | Database System Concepts, | Sliberschatz Korth and S. Sudarshan | McGraw Hill, | 7/e, 2017 |
| 2 | NoSQL for Dummies | Adam Fowler | John Wiley & Sons | 1/e, 2015 |
| 3 | NoSQL Data Models: Trends and Challenges (Computer Engineering: Databases and Big Data), | Olivier Pivert | Wiley | 1/e, 2018 |
| 4 | Making the Sense of NoSQL: A guide for Managers and Rest of us. | Dan McCreary and Ann Kelly | Manning | 1/e, 2014 |

| Video Links (NPTEL, SWAYAM…) | |
|---|---|
| **Module No.** | **Link ID** |
| **1** | https://onlinecourses.nptel.ac.in/noc21_cs04/preview |
| **2** | https://onlinecourses.nptel.ac.in/noc21_cs04/preview |
| **3** | https://onlinecourses.nptel.ac.in/noc21_cs04/preview |
| **4** | https://archive.nptel.ac.in/courses/106/104/106104135/ |

## Continuous Assessment (25 Marks)

1. **Preparation and Pre-Lab Work (7 Marks)**
   - Pre-Lab Assignments: Assessment of pre-lab assignments or quizzes that test understanding of the upcoming experiment.
   - Understanding of Theory: Evaluation based on students' preparation and understanding of the theoretical background related to the experiments.

2. **Conduct of Experiments (7 Marks)**
   - Procedure and Execution: Adherence to correct procedures, accurate execution of experiments, and following safety protocols.
   - Skill Proficiency: Proficiency in handling equipment, accuracy in observations, and troubleshooting skills during the experiments.
   - Teamwork: Collaboration and participation in group experiments.

3. **Lab Reports and Record Keeping (6 Marks)**
   - Quality of Reports: Clarity, completeness and accuracy of lab reports. Proper documentation of experiments, data analysis and conclusions.
   - Timely Submission: Adhering to deadlines for submitting lab reports/rough record and maintaining a well-organized fair record.

4. **Viva Voce (5 Marks)**
   - Oral Examination: Ability to explain the experiment, results and underlying principles during a viva voce session.

***Final Marks Averaging: The final marks for preparation, conduct of experiments, viva, and record are the average of all the specified experiments in the syllabus.***

## Evaluation Pattern for End Semester Examination (50 Marks)

1. **Procedure/Preliminary Work/Design/Algorithm (10 Marks)**
   - Procedure Understanding and Description: Clarity in explaining the procedure and understanding each step involved.
   - Preliminary Work and Planning: Thoroughness in planning and organizing materials/equipment.

- Algorithm Development: Correctness and efficiency of the algorithm related to the experiment.
- Creativity and logic in algorithm or experimental design.

2. **Conduct of Experiment/Execution of Work/Programming (15 Marks)**
   - Setup and Execution: Proper setup and accurate execution of the experiment or programming task.

3. **Result with Valid Inference/Quality of Output (10 Marks)**
   - Accuracy of Results: Precision and correctness of the obtained results.
   - Analysis and Interpretation: Validity of inferences drawn from the experiment or quality of program output.

4. **Viva Voce (10 Marks)**
   - Ability to explain the experiment, procedure results and answer related questions
   - Proficiency in answering questions related to theoretical and practical aspects of the subject.

5. **Record (5 Marks)**
   - Completeness, clarity, and accuracy of the lab record submitted

# PROGRAM ELECTIVE-1

| SLOT | COURSE CODE | COURSES | L-T-P-R | HOURS | CREDIT |
|---|---|---|---|---|---|
| E | 24SJPECST411 | Software Engineering | 3-0-0-0 | 3 | 3 |
| | 24SJPEADT412 | Data Science Privacy & Ethics | 3-0-0-0 | | 3 |
| | 24SJPECST413 | Functional Programming | 3-0-0-0 | | 3 |
| | 24SJPEADT414 | Fundamentals of Bioinformatics | 3-0-0-0 | | 3 |
| | 24SJPEADT416 | Number Theory | 3-0-0-0 | | 3 |
| | 24SJPECST417 | Soft Computing | 3-0-0-0 | | 3 |
| | 24SJPEADT418 | Microcontrollers | 3-0-0-0 | | 3 |
| | 24SJPEADT415 | Foundations of Pattern Recognition | 3-0-0-0 | | 5/3 |

# SEMESTER S4

## SOFTWARE ENGINEERING

(Common to CS/CA/AD)

| | | | |
|---|---|---|---|
| **Course Code** | **24SJPECST411** | **CIE Marks** | 40 |
| **Teaching Hours/Week (L: T:P: R)** | 3:0:0:0 | **ESE Marks** | 60 |
| **Credits** | 3 | **Exam Hours** | 2 Hrs. 30 Min. |
| **Prerequisites (if any)** | None | **Course Type** | Theory |

**Course Objectives:**

1. To Provide fundamental knowledge in the Software Development Process including Software Development, Object Oriented Design, Project Management concepts and technology trends.
2. To enable the learners to apply state of the art industry practices in Software development.

## SYLLABUS

| Module No. | Syllabus Description | Contact Hours |
|---|---|---|
| 1 | **Introduction to Software Engineering and Process Models -** Software engineering, Software characteristics and types, Layers of Software Engineering-Process, Methods, Tools and Quality focus. Software Process models – Waterfall, Prototype, Spiral, Incremental, Agile model – Values and Principles.<br>**Requirement engineering -** Functional, Non-functional, System and User requirements. Requirement elicitation techniques, Requirement validation, Feasibility analysis and its types, SRS document characteristics and its structure. *Case study:* SRS for College Library Management Software | **9** |
| 2 | **Software design -** Software architecture and its importance, Software architecture patterns: Component and Connector, Layered, Repository, Client- Server, Publish-Subscribe, Functional independence – Coupling and Cohesion *Case study:* Ariane launch failure<br>**Object Oriented Software Design -** UML diagrams and relationships– Static and dynamic models, Class diagram, State diagram, Use case diagram, Sequence diagram<br>*Case Studies*: Voice mail system, ATM Example<br>**Software pattern -** Model View Controller, Creational Design Pattern types – | **9** |

| | | |
|---|---|---|
| | Factory method, Abstract Factory method, Singleton method, Prototype method, Builder method. Structural Design Pattern and its types – Adapter, Bridge, Proxy, Composite, Decorator, Façade, Flyweight. Behavioral Design Pattern | |
| **3** | **Coding, Testing and Maintenance:**<br>**Coding guidelines** - Code review, Code walkthrough and Code inspection, Code debugging and its methods.<br>**Testing** - Unit testing, Integration testing, System testing and its types, Black box testing and White box testing, Regression testing<br>**Overview of DevOps and Code Management** - Code management, DevOps automation, Continuous Integration, Delivery, and Deployment (CI/CD/CD), *Case study* – Netflix.<br>**Software maintenance and its types-** Adaptive, Preventive, Corrective and Perfective maintenance. Boehm's maintenance models (both legacy and non- legacy) | **9** |
| **4** | **Software Project Management** - Project size metrics – LOC, Function points and Object points. Cost estimation using Basic COCOMO.<br>Risk management: Risk and its types, Risk monitoring and management model **Software Project Management** - Planning, Staffing, Organizational structures, Scheduling using Gantt chart. Software Quality Management – ISO 9000, CMM, Six Sigma for software engineering.<br>**Cloud-based Software** -Virtualisation and containers, Everything as a service (IaaS, PaaS), Software as a service. Microservices Architecture - Microservices, Microservices architecture, Microservice deployment. | **9** |

**Course Assessment Method**
**(CIE: 40 marks, ESE: 60 marks)**

**Continuous Internal Evaluation Marks (CIE):**

| Attendance | Assignment/ Micro project | Internal Examination-1 (Written) | Internal Examination-2 (Written) | Total |
|---|---|---|---|---|
| 5 | 15 | 10 | 10 | 40 |

**End Semester Examination Marks (ESE)**

*In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions*

| Part A | Part B | Total |
|---|---|---|
| • 2 Questions from each module.<br>• Total of 8 Questions, each carrying 3 marks<br>**(8x3 =24 marks)** | • Each question carries 9 marks.<br>• Two questions will be given from each module, out of which 1 question should be answered.<br>• Each question can have a maximum of 3 sub divisions.<br>**(4x9 = 36 marks)** | **60** |

**Course Outcomes (COs)**

At the end of the course students should be able to:

| | Course Outcome | Bloom's Knowledge Level (KL) |
|---|---|---|
| **CO1** | Plan the system requirements and recommend a suitable software process model | K3 |
| **CO2** | Model various software patterns based on system requirements | K3 |
| **CO3** | Apply testing and maintenance strategies on the developed software product to enhance quality | K3 |
| **CO4** | Develop a software product based on cost, schedule and risk constraints | K3 |

Note: *K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

**CO-PO Mapping Table:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | ✓ | ✓ | ✓ | | | | | | | | ✓ |
| **CO2** | ✓ | ✓ | ✓ | | | | | | | | ✓ |
| **CO3** | ✓ | ✓ | ✓ | | | | | | | | ✓ |
| **CO4** | ✓ | ✓ | ✓ | | | | | | | | ✓ |

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*
**Correlation value will be fixed in the course committee meeting*

| Text Books | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| 1 | Software Engineering: A practitioner's approach | Roger S. Pressman | McGraw-Hill International edition | 8/e, 2014 |
| 2 | Software Engineering | Ian Sommerville | Addison-Wesley | 10/e, 2015 |
| 3 | Design Patterns, Elements of Reusable Object Oriented Software | Erich Gamma, Richard Helm, Ralph Johnson, John Vlissides | Pearson Education Addison-Wesley | 1/e, 2009 |

| Reference Books | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| 1 | Pankaj Jalote's Software Engineering: With Open Source and GenAI | Pankaj Jalote | Wiley India | 1/e, 2024 |
| 2 | Software Engineering: A Primer | Waman S Jawadekar | Tata McGraw-Hill | 1/e, 2008 |
| 3 | Object-Oriented Modeling and Design with UML | Michael Blaha, James Rumbaugh | Pearson Education. | 2/e, 2007 |
| 4 | Software Engineering Foundations: A Software Science Perspective | Yingux Wang | Auerbach Publications | 1/e, 2008 |
| 5 | Object-Oriented Design and Patterns | Cay Horstmann | Wiley India | 2/e, 2005 |
| 6 | Engineering Software Products: An Introduction to Modern Software Engineering | Ian Sommerville | Pearson Education | 1/e, 2020 |

| Video Links (NPTEL, SWAYAM…) | |
|---|---|
| **Module No.** | **Link ID** |
| **1** | https://www.youtube.com/watch?v=Z6f9ckEElsU |
| **2** | https://www.youtube.com/watch?v=1xUz1fp23TQ |
| **3** | http://digimat.in/nptel/courses/video/106105150/L01.html |
| **4** | https://www.youtube.com/watch?v=v7KtPLhSMkU |

## SEMESTER S4

## DATA SCIENCE PRIVACY & ETHICS

| | | | |
|---|---|---|---|
| **Course Code** | **24SJPEADT412** | **CIE Marks** | 40 |
| **Teaching Hours/Week (L: T:P: R)** | 3:0:0:0 | **ESE Marks** | 60 |
| **Credits** | 3 | **Exam Hours** | 2 Hrs. 30 Min. |
| **Prerequisites (if any)** | None | **Course Type** | Theory |

**Course Objectives:**

1. To understand the fundamental principles of data ethics and privacy.
2. To analyze real-world cases involving data privacy and ethical issues.
3. To develop skills to implement ethical practices in data science projects.
4. To learn about legal frameworks governing data privacy.

### SYLLABUS

| Module No. | Syllabus Description | Contact Hours |
|---|---|---|
| 1 | Data & Risks:-<br>Data access and analysis – Risk mitigation – Risks, Harms and Benefit assessment – Sensitive data – Sensitive contexts – Data security – Data Retention;<br>Data Ethics – the importance of data ethics –Privacy, transparency, fairness and bias, accountability, security, data quality; Data collection – The ethical use of data. | 9 |
| 2 | Data Privacy:<br>Introduction to Data privacy – History of privacy, Degrees of privacy, Modern privacy risks, Anonymity; Data validity – Choice of Attributes and Measures; Errors in Data Processing – Errors in Model Design, Algorithmic Fairness.<br>Data ownership; Data Integrity – Biased and Unbiased data, Fairness; Five C's of data; Anonymization; Key issues in Data ethics; Open data usage – Features and characteristics. | 9 |

| | | |
|---|---|---|
| 3 | Database Security and Analytics :-<br>Relational databases; Database features; Metadata - Importance, Descriptive and structural metadata, Schemas, Metadata management; Common security challenges- Human error, SQL injection attacks, DDoS, Malware attacks; Prevention methods- Access control, Auditing, Authentication, Encryption, Integrity controls, Backups. | 9 |
| 4 | Ethics and Data Protection :-<br>Government regulatory frameworks – Data Protection laws- GDPR, CCPA, Security standards; Data retention policies - GDPR retention policy, 7 year retention policy; Compliance and audits; International standards - ISO/IEC standard; Real world case studies. | 9 |

**Course Assessment Method**
**(CIE: 40 marks, ESE: 60 marks)**

**Continuous Internal Evaluation Marks (CIE):**

| Attendance | Assignment/ Microproject | Internal Examination-1 (Written) | Internal Examination- 2 (Written) | Total |
|---|---|---|---|---|
| 5 | 15 | 10 | 10 | 40 |

**End Semester Examination Marks (ESE)**

*In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions*

| Part A | Part B | Total |
|---|---|---|
| • 2 Questions from each module.<br>• Total of 8 Questions, each carrying 3 marks<br>**(8x3 =24 marks)** | • Each question carries 9 marks.<br>• Two questions will be given from each module, out of which 1 question should be answered.<br>• Each question can have a maximum of 3 subdivisions.<br>**(4x9 = 36 marks)** | **60** |

## Course Outcomes (COs)

At the end of the course students should be able to:

| Course Outcome | | Bloom's Knowledge Level (KL) |
|---|---|---|
| **CO1** | Understand Ethical Data Collection and Usage. | **K2** |
| **CO2** | Understand Ethical Principles in Data Science. | **K2** |
| **CO3** | Identify Data Privacy Issues. | **K3** |
| **CO4** | Illustrate Legal and Regulatory Frameworks. | **K3** |
| **CO5** | Identify Real-World privacy and ethics violation Cases. | **K3** |

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

**CO-PO Mapping Table:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | | | | 2 | | 2 | | | 3 |
| **CO2** | 2 | 2 | | | | 2 | | 2 | | | 3 |
| **CO3** | 3 | 2 | 2 | | | 2 | | 2 | | | 3 |
| **CO4** | 3 | 2 | 2 | | | 2 | | 2 | | | 3 |
| **CO5** | 3 | 2 | 2 | | | 2 | | 2 | | | 3 |

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

| Text Books | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| **1** | Ethics and Data Science | Mike Loukides, Hilary Mason, and DJ Patil | O'Reilly Media | 1/e, 2018 |
| **2** | Data Privacy: Principles and Practice | Nataraj Venkataramanan and Ashwin Shriram | CRC Press | 1/e, 2017 |
| **3** | The Ethical Algorithm: The Science of Socially Aware Algorithm Design | Michael Kearns and Aaron Roth | Oxford University Press | 1/e, 2019 |

| Reference Books | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| **1** | Data Privacy Law A Practical Guide to the GDPR | G.E. Kennedy, L.S.P. Prabhu, | G.E. Kennedy & L.S.P. Prabhu | 3/e, 2020 |

| Video Links (NPTEL, SWAYAM…) | |
|---|---|
| **No.** | **Link ID** |
| **1** | Online Privacy: https://onlinecourses.nptel.ac.in/noc22_cs37/preview |
| **2** | Towards an Ethical Digital Society- From Theory to Practice: https://onlinecourses.nptel.ac.in/noc21_hs55/preview |

## SEMESTER S4

# FUNCTIONAL PROGRAMMING

(Common to CS/CA/AD)

| | | | |
|---|---|---|---|
| **Course Code** | **24SJPECST413** | **CIE Marks** | 40 |
| **Teaching Hours/Week (L: T:P: R)** | 3:0:0:0 | **ESE Marks** | 60 |
| **Credits** | 3 | **Exam Hours** | 2 Hrs. 30 Min. |
| **Prerequisites (if any)** | 24SJGXEST204 | **Course Type** | Theory |

**Course Objectives:**

1. To enable the learner write programs in a functional style and reason formally about functional programs;
2. To give the concepts of polymorphism and higher-order functions in Haskell to solve the

## SYLLABUS

| Module No. | Syllabus Description | Contact Hours |
|---|---|---|
| **1** | Introducing Functional Programming; Getting Started with Haskell and GHCi; Basic Types and Definitions; Designing and Writing Programs; Data Types, Tuples and Lists.<br>***[Text Ch. 1, 2, 3, 4, 5]*** | **9** |
| **2** | Programming with Lists; Defining Functions over Lists; Playing the Game: I/O in Haskell; Reasoning about Programs;<br>***[Text Ch. 6, 7, 8, 9]*** | **9** |
| **3** | Generalization: Patterns of Computation; Higher-order Functions; Developing Higher-order Programs; Overloading, Type Classes and Type Checking.<br>***[Text Ch. 10 11, 12, 13]*** | **9** |
| **4** | Algebraic Types; Case Study - Huffman Codes; Abstract Data Types; Lazy Programming; Time and Space Behaviour.<br>***[Text Ch. 15, 16, 17, 20]*** | **9** |

**Course Assessment Method**

**(CIE: 40 marks, ESE: 60 marks)**

**Continuous Internal Evaluation Marks (CIE):**

| Attendance | Assignment/ Microproject | Internal Examination-1 (Written) | Internal Examination- 2 (Written) | Total |
|---|---|---|---|---|
| 5 | 15 | 10 | 10 | 40 |

**End Semester Examination Marks (ESE)**

*In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions*

| Part A | Part B | Total |
|---|---|---|
| • 2 Questions from each module.<br>• Total of 8 Questions, each carrying 3 marks<br>**(8x3 =24 marks)** | • Each question carries 9 marks.<br>• Two questions will be given from each module, out of which 1 question should be answered.<br>• Each question can have a maximum of 3 subdivisions.<br>**(4x9 = 36 marks)** | **60** |

**Course Outcomes (COs)**

At the end of the course students should be able to:

| | Course Outcome | Bloom's Knowledge Level (KL) |
|---|---|---|
| **CO1** | Write computer programs in a functional style. | **K2** |
| **CO2** | Reason formally about functional programs and develop programs using lists. | **K3** |
| **CO3** | Use patterns of computation and higher-order functions. | **K3** |
| **CO4** | Reason informally about the time and space complexity of programs. | **K3** |

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

**CO-PO Mapping Table:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | ✓ | ✓ | | | ✓ | | | | | | ✓ |
| **CO2** | ✓ | ✓ | ✓ | | ✓ | | | | | | ✓ |
| **CO3** | ✓ | ✓ | ✓ | | ✓ | | | | | | ✓ |
| **CO4** | ✓ | ✓ | ✓ | | ✓ | | | | | | ✓ |

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*
**Correlation value will be fixed in the course committee meeting*

| **Text Books** | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| **1** | HASKELL: The Craft of Functional Programming | Simon Thompson | Addison Wesley | 3/e, 2023 |

| **Reference Books** | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| **1** | Thinking Functionally with Haskell | Richard Bird | Cambridge University Press | 1/e, 2015 |
| **2** | Programming in Haskell | Graham Hutton | Cambridge University Press | 2/e, 2023 |
| **3** | Real World Haskell | Bryan O'Sullivan, John Goerzen, Donald Bruce Stewart | O'Reilly | 1/e, 2008 |

| **Video Links (NPTEL, SWAYAM…)** | |
|---|---|
| **No.** | **Link ID** |
| **1** | https://archive.nptel.ac.in/courses/106/106/106106137/ |

## SEMESTER S4

## FUNDAMENTALS OF BIOINFORMATICS

| | | | |
|---|---|---|---|
| **Course Code** | **24SJPEADT414** | **CIE Marks** | 40 |
| **Teaching Hours/Week (L: T:P: R)** | 3:0:0:0 | **ESE Marks** | 60 |
| **Credits** | 3 | **Exam Hours** | 2 Hrs. 30 Min. |
| **Prerequisites (if any)** | None | **Course Type** | Theory |

**Course Objectives:**

1. To understand the fundamental concepts in Molecular Biology, Genomics, Proteomics and Modelling.
2. To introduce bio macromolecules such as genes and proteins, different biological databases, and tools and algorithms for biological data processing, analysis and interpretation, and the elements of the systems approach to Molecular Biology.

## SYLLABUS

| Module | Syllabus Description | Contact Hours |
|---|---|---|
| 1 | **Molecular Biology Primer (3 hours)**<br>Genes,DNAs, RNAs, Proteins, Genomics, Sequencing techniques, Bioinformatics overview and scope<br>**Sequence Alignment (6 hours)**<br>Global and local sequence alignment-dynamic programming algorithms, edit distance, similarity, Needleman Wunsch Algorithm, Smith Waterman Algorithm | 9 |
| 2 | **Biological Databases and Data Formats (3 hours)**<br>Genomic and Sequence Data Formats, GenBank, EMBL-Bank, and DDBJ, PROSITE, NCBI- Database Searching: BLAST, FASTA<br>**Phylogenetics (6 hours)**<br>Phylogenetic Tree basics and Construction Methods, UPGMA, Neighbour joining, Parsimonous trees, Additive trees, Bootstrapping | 9 |
| 3 | **Combinatorial Pattern Matching (9 hours)**<br>Combinatorial Pattern Matching, Repeat finding, Keyword Trees, Suffix Trees, Heuristic similarity search algorithms, Approximate Pattern Matching<br>***Introduction to NGS, ML & bio informatics, Ethical use of biological data***. | 9 |

| | | |
|---|---|---|
| 4 | **R FOR BIOINFORMATICS**<br>Variables, Data types, control flow constructs, String manipulation, Pattern Matching, arrays, lists and hashes, File handling, Programs to handle biological data and parse output files for interpretation, packages for sequence alignment, FASTA, BLAST (Bioconductor, msa, Biostrings etc.) | **9** |

**Course Assessment Method**
**(CIE: 40 marks, ESE: 60 marks)**

**Continuous Internal Evaluation Marks (CIE):**

| Attendance | Assignment/ Microproject | Internal Examination-1 (Written) | Internal Examination- 2 (Written) | Total |
|---|---|---|---|---|
| 5 | 15 | 10 | 10 | 40 |

**End Semester Examination Marks (ESE)**

*In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions*

| Part A | Part B | Total |
|---|---|---|
| • 2 Questions from each module.<br>• Total of 8 Questions, each carrying 3 marks<br>**(8x3 =24 marks)** | • Each question carries 9 marks.<br>• Two questions will be given from each module, out of which 1 question should be answered.<br>• Each question can have a maximum of 3 subdivisions.<br>**(4x9 = 36 marks)** | **60** |

## Course Outcomes (COs)

At the end of the course students should be able to:

| Course Outcome | | Bloom's Knowledge Level (KL) |
|---|---|---|
| **CO1** | Understand the Basics of Bioinformatics | **K2** |
| **CO2** | Use various biological databases and apply sequence alignment techniques | **K3** |
| **CO3** | Use molecular phylogenetics and NGS data to explore evolutionary relationships. | **K3** |
| **CO4** | Apply the concept of combinatorial pattern matching in bioinformatics | **K3** |
| **CO5** | Apply R programming techniques and bioinformatics packages to manipulate biological data and interpret results. | **K3** |

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

**CO-PO Mapping Table:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | | | | | | | | 2 |
| **CO2** | 3 | 3 | 3 | | | | | | | | 2 |
| **CO3** | 3 | 3 | 3 | | | | | | | | 2 |
| **CO4** | 3 | 3 | 3 | | | | | | | | 2 |
| **CO5** | 3 | 3 | 3 | | 2 | | | | | | 2 |

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

| Text Books | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| 1 | An Introduction to Bioinformatics Algorithms, | N. C. Jones and P. A. Pevzner, | MIT Press, 2004 | 1/e, 2004 |
| 2 | Bioinformatics for Beginners: Genes, Genomes, Molecular Evolution, Databases and Analytical Tools | Supratim Choudhuri | Academic Press | 1/e, 2014 |

| Reference Books | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| 1 | Introduction to Bioinformatics | T. K. Attwood and D. J. Parry-Smith, | Pearson Education | 1/e, 2003 |
| 2 | Analysis of Biological Networks, | B. Junker and F.Schreiber, | Wiley Publishers | 1/e, 2007 |
| 3 | Heterogeneous Information Networks - Principles & Methodologies | Y. Sun and J. Han, Mining | Morgan & Claypool Publishers | 1/e, 2012 |
| 4 | Multilayer Social Networks, | M. E. Dickison et al, | Cambridge University Press | 1/e, 2016 |

| Video Links (NPTEL, SWAYAM…) | |
|---|---|
| **No.** | **Link ID** |
| **1** | https://archive.nptel.ac.in/courses/102/106/102106065/ |
| **2** | https://onlinecourses.swayam2.ac.in/cec21_bt04/preview |

## SEMESTER S4

## NUMBER THEORY

| | | | |
|---|---|---|---|
| **Course Code** | **24SJPEADT416** | **CIE Marks** | 40 |
| **Teaching Hours/Week (L: T:P: R)** | 3:0:0:0 | **ESE Marks** | 60 |
| **Credits** | 3 | **Exam Hours** | 2 Hrs. 30 Min. |
| **Prerequisites (if any)** | None | **Course Type** | Theory |

**Course Objectives:**

1. To provide the basic concepts of divisibility and prime numbers.
2. To enable the learners develop problem-solving skills in the context of number theory.

## SYLLABUS

| Module No. | Syllabus Description | Contact Hours |
|---|---|---|
| 1 | Fundamentals - Polygonal numbers, Pyramidal numbers, Catalan numbers; Divisibility-Division algorithm, Number patterns, Prime and composite numbers, Fibonacci and Lucas numbers, Fermat numbers; Greatest common divisors - Greatest common divisor, Euclidean algorithm, Least Common Multiple, Linear Diophantine Equations. | 9 |
| 2 | Congruences – Congruences (Basics only), Linear congruences; Congruence Applications - divisibility tests, Modular designs, Check digits; Systems of Linear Congruences- Chinese remainder theorem, General Linear systems, 2x2 Linear systems; Wilson's theorem; Fermat's little theorem (Theorem and proof of theorem only). | 9 |
| 3 | Multiplicative Functions – Euler's Phi Function, Euler's Theorem, Tau and sigma function, Perfect numbers, Mersenne Primes; Primitive Roots- Order of a positive integer, Primality tests, Primitive roots of primes, Composites with primitive roots. | 9 |
| 4 | Cryptology - Affine ciphers, Hill ciphers, Exponentiation ciphers, RSA Crypto System, Knapsack Ciphers. | 9 |

**Course Assessment Method**

**(CIE: 40 marks, ESE: 60 marks)**

**Continuous Internal Evaluation Marks (CIE):**

| Attendance | Assignment/ Microproject | Internal Examination-1 (Written) | Internal Examination- 2 (Written) | Total |
|---|---|---|---|---|
| 5 | 15 | 10 | 10 | 40 |

**End Semester Examination Marks (ESE)**

*In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions*

| Part A | Part B | Total |
|---|---|---|
| • 2 Questions from each module.<br>• Total of 8 Questions, each carrying 3 marks<br>**(8x3 =24 marks)** | • Each question carries 9 marks.<br>• Two questions will be given from each module, out of which 1 question should be answered.<br>• Each question can have a maximum of 3 subdivisions.<br>**(4x9 = 36 marks)** | **60** |

**Course Outcomes (COs)**

At the end of the course students should be able to:

| | Course Outcome | Bloom's Knowledge Level (KL) |
|---|---|---|
| **CO1** | Illustrate the operations and properties of integer arithmetic. | **K2** |
| **CO2** | Use the concepts of prime numbers and factorization. | **K2** |
| **CO3** | Solve Diophantine equations and congruences. | **K3** |
| **CO4** | Use the concepts of the order of a positive integer, primality tests, and primitive roots of primes for ensuring security in computing systems. | **K3** |
| **CO5** | Illustrate classical theorems of Number theory and Apply number theory to ciphers. | **K3** |

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

**CO-PO Mapping Table:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 2 | 3 | - | - | - | - | - | - | 3 |
| **CO2** | 3 | 3 | 2 | 2 | - | - | 2 | - | - | - | 3 |
| **CO3** | 3 | 3 | 2 | 2 | - | - | 2 | - | - | - | 3 |
| **CO4** | 3 | 3 | 2 | 2 | - | - | - | - | - | - | 3 |
| **CO5** | 2 | 2 | - | 2 | 2 | - | - | - | - | - | 3 |

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

| **Text Books** | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| **1** | Elementary Number Theory with Applications | Thomas Koshy | Elsevier Academic Press | 2/e, 2007 |

| **Reference Books** | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| **1** | Elementary Number Theory | David M Burton | McGraw Hill | 7/e, 2011 |
| **2** | Elementary Number Theory | Gareth A Jones, J Mary Jones | Springer | 1/e, 1998 |
| **3** | Elementary Number Theory | Kenneth H Rosen | Pearson Education | 6/e, 2015 |

| **Video Links (NPTEL, SWAYAM…)** | |
|---|---|
| **Module No.** | **Link ID** |
| **1** | https://archive.nptel.ac.in/course.html |
| **2** | https://archive.nptel.ac.in/courses/111/101/111101137/ |

# SEMESTER S4

## SOFT COMPUTING

| | | | |
|---|---|---|---|
| **Course Code** | **24SJPECST417** | **CIE Marks** | 40 |
| **Teaching Hours/Week (L: T: P: R)** | 3:0:0:0 | **ESE Marks** | 60 |
| **Credits** | 3 | **Exam Hours** | 2 Hrs. 30 Min. |
| **Prerequisites (if any)** | None | **Course Type** | Theory |

**Course Objectives:**

1. To give exposure on soft computing, various types of soft computing techniques, and applications of soft computing
2. To impart solid foundations on Neural Networks, its architecture, functions and various algorithms involved, Fuzzy Logic, various fuzzy systems and their functions, and Genetic algorithms, its applications and advances.

## SYLLABUS

| Module No. | Syllabus Description | Contact Hours |
|---|---|---|
| 1 | Introduction to Soft Computing. Difference between Hard Computing & Soft Computing. Applications of Soft Computing. Artificial Neurons Vs Biological Neurons. Activation Functions. McCulloch and Pitts Neuron. Hebb network, Perceptron Networks– Learning rule, Training and testing algorithm. Adaptive Linear Neuron– Architecture, Training and testing algorithm. | 10 |
| 2 | Fuzzy logic, Fuzzy sets – Properties, Fuzzy membership functions, Features of Fuzzy membership functions. operations on fuzzy set. Linguistic variables, Fuzzy Relations, Fuzy If-Then Rules, Fuzzification, Defuzzification– Lamda cuts, Defuzzification methods. Fuzzy Inference mechanism - Mamdani and Sugeno types. | 10 |
| 3 | Evolutionary Computing, Terminologies of Evolutionary Computing, Concepts of genetic algorithm. Operators in genetic algorithm – coding, selection, cross over, mutation. Stopping condition for genetic algorithm. | 8 |
| 4 | Multi-objective optimization problem. Principles of Multi- objective optimization, Dominance and pareto-optimality. Optimality conditions. Collective Systems, Biological Self- Organization, Particle Swarm Optimization, Ant Colony Optimization, Swarm Robotics. | 9 |

## Course Assessment Method

## (CIE: 40 marks, ESE: 60 marks)

### Continuous Internal Evaluation Marks (CIE):

| Attendance | Assignment/ Microproject | Internal Examination-1 (Written) | Internal Examination-2 (Written) | Total |
|---|---|---|---|---|
| 5 | 15 | 10 | 10 | 40 |

### End Semester Examination Marks (ESE)

*In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions*

| Part A | Part B | Total |
|---|---|---|
| • 2 Questions from each module.<br>• Total of 8 Questions, each carrying 3 marks<br>**(8x3 =24 marks)** | • Each question carries 9 marks.<br>• Two questions will be given from each module, out of which 1 question should be answered.<br>• Each question can have a maximum of 3 subdivisions.<br>**(4x9 = 36 marks)** | **60** |

**Course Outcomes (COs)**

At the end of the course students should be able to:

| Course Outcome | | Bloom's Knowledge Level (KL) |
|---|---|---|
| **CO1** | Describe the techniques used in soft computing and outline the fundamental models of artificial neural networks | **K2** |
| **CO2** | Solve practical problems using neural networks | **K3** |
| **CO3** | Illustrate the operations, model, and applications of fuzzy logic. | **K3** |
| **CO4** | Illustrate the concepts of evolutionary algorithms such as Genetic Algorithm | **K3** |
| **CO5** | Describe the concepts of multi-objective optimization models and collective systems. | **K2** |

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

**CO-PO Mapping Table:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | ✓ | ✓ | ✓ | | | | | | | | ✓ |
| **CO2** | ✓ | ✓ | ✓ | ✓ | | | | | | | ✓ |
| **CO3** | ✓ | ✓ | ✓ | ✓ | | | | | | | ✓ |
| **CO4** | ✓ | ✓ | ✓ | ✓ | | | | | | | ✓ |
| **CO5** | ✓ | ✓ | ✓ | | | | | | | | ✓ |

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*
**Correlation value will be fixed in the course committee meeting*

| Text Books | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| **1** | Principles of Soft Computing | S.N. Sivanandam, S.N. Deepa | John Wiley & Sons. | 3/e, 2018 |
| **2** | Multi-objective Optimization using Evolutionary Algorithms | Kalyanmoy Deb, | John Wiley & Sons | 1/e, 2009 |
| **3** | Computational intelligence: synergies of fuzzy logic, neural networks and evolutionary computing. | Siddique N, Adeli H. | John Wiley & Sons | 1/e, 2013 |
| **4** | Bio-inspired artificial intelligence: theories, methods, and technologies. | Floreano D, Mattiussi C. | MIT press; 2008 Aug 22. | 1/e, 2023 |

| Reference Books | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| 1 | Fuzzy Logic with Engineering Applications | Timothy J Ross, | John Wiley & Sons, | 3/e, 2011 |
| 2 | Neural Networks, Fuzzy Logic & Genetic Algorithms Synthesis and Applications | T.S.Rajasekaran, G.A.Vijaylakshmi Pai | Prentice-Hall India | 1/e, 2003 |
| 3 | Neural Networks- A Comprehensive Foundation | Simon Haykin | Pearson Education | 2/e, 1997 |
| 4 | Fuzzy Set Theory & Its Applications | Zimmermann H. J, | Allied Publishers Ltd. | 4/e, 2001 |

| Video Links (NPTEL, SWAYAM…) | |
|---|---|
| **No.** | **Link ID** |
| **1** | https://archive.nptel.ac.in/courses/106/105/106105173/ |

## SEMESTER S4

## MICROCONTROLLERS

| | | | |
|---|---|---|---|
| **Course Code** | **24SJPEADT418** | **CIE Marks** | 40 |
| **Teaching Hours/Week (L:T:P:R)** | 3:0:0:0 | **ESE Marks** | 60 |
| **Credits** | 3 | **Exam Hours** | 2 Hrs. 30 Min. |
| **Prerequisites (if any)** | None | **Course Type** | Theory |

**Course Objectives:**

1. To introduce the ARM architecture and ARM-based microcontroller architecture.
2. To impart knowledge on the hardware and software components to develop embedded systems using STM32 microcontrollers.

**SYLLABUS**

| Module No. | Syllabus Description | Contact Hours |
|---|---|---|
| 1 | **Introduction to Embedded Systems and ARM Cortex-M Architecture:-**<br>Overview of embedded systems including definition, applications, and characteristics, Embedded C Programming Basics and Key Concepts, Differences and use cases of microcontrollers versus microprocessors, Classification of processors including RISC, CISC, and other architectures, Overview of ARM Cortex-M Series features and applications, Introduction to Cortex-M23 and Cortex-M33 Processors: Armv8-M Architecture, Core Features (Registers, Memory, Bus Architecture),Comparison with Previous Cortex-M Generations. | 8 |
| 2 | **STM32 Microcontroller Overview and Development Environment Setup:-**<br>Overview of the STM32 Family and Features of the STM32U575, Development Environment and HAL- Introduction, Writing, and Debugging Your First Program (LED Interfacing); Interfacing - Seven-Segment Display, LCD Display, Matrix Keypad, Relay, Analog to Digital Conversion- Potentiometer, Temperature Sensor, LDR, Microphone, Digital to Analog<br>Conversion - Simple DAC Output, Sine Wave Generation, Audio Signal Generation, Interrupt Handling Basics and Applications, Timers and PWM: Configuration, Real-Time Clock (RTC), LED Brightness Control, Motor Speed Control | 10 |

| | | |
|---|---|---|
| **3** | **Communication Protocols :-**<br><br>Overview of Serial Communication Protocols- USART, I2C, and SPI, Interfacing an I2C Temperature Sensor and Displaying Data on an LCD, writing to and Reading from an SPIbased EEPROM, Implementing CAN Communication Between STM32 Microcontrollers; Creating a USB HID Device for Keyboard and Mouse Emulation. | **9** |
| **4** | **IoT and RTOS:-**<br><br>Introduction to IoT and its Layers of Architecture, Introduction to IoT Communication Protocols including MQTT, CoAP, and HTTP, Securing IoT Data Using Encryption Techniques, Wireless Communication Basics- GSM, Interfacing GSM (Sending SMS, Making Calls, Internet Connectivity Using AT Commands), Bluetooth (Data Transfer between STM32U575 and Mobile<br><br>Devices), RTOS Concepts: Free RTOS Overview, Task Creation, Scheduling, Timers, Inter-task Communication (Queues, Semaphores), Designing an IoT-Based Home Automation System. | **9** |

**Course Assessment Method**
**(CIE: 40 marks, ESE: 60 marks)**

**Continuous Internal Evaluation Marks (CIE):**

| Attendance | Assignment/ Microproject | Internal Examination-1 (Written) | Internal Examination- 2 (Written) | Total |
|---|---|---|---|---|
| 5 | 15 | 10 | 10 | 40 |

**End Semester Examination Marks (ESE)**

*In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions.*

| Part A | Part B | Total |
|---|---|---|
| • 2 Questions from each module.<br>• Total of 8 Questions, each carrying 3 marks<br>**(8x3 =24 marks)** | • Each question carries 9 marks.<br>• Two questions will be given from each module, out of which 1 question should be answered.<br>• Each question can have a maximum of 3 subdivisions.<br>**(4x9 = 36 marks)** | **60** |

**Course Outcomes (COs)**

At the end of the course students should be able to:

| | Course Outcome | Bloom's Knowledge Level (KL) |
|---|---|---|
| **CO1** | Explain the architectural features and instructions of the ARM microcontrollers. | **K2** |
| **CO2** | Develop applications involving interfacing of external devices and I/O with ARM microcontroller. | **K3** |
| **CO3** | Use various communication protocols of interaction with peer devices and peripherals. | **K3** |
| **CO4** | Demonstrate the use of a real time operating system in embedded system applications. | **K3** |

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

**CO-PO Mapping Table:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | | | | | | | | 3 |
| **CO2** | 3 | 3 | 3 | | | | | | | | 3 |
| **CO3** | 3 | 3 | 3 | 3 | 3 | | | | | | 3 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | | | | | | 3 |

| Text Books | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| **1** | The Definitive Guide to ARM Cortex- M3 and Cortex-M4 Processors | Joseph Yiu | Newnes - Elsevier | 3/e, 2014 |
| **2** | Mastering STM32 | Carmine Noviello | Learnpub | 2/e, 2022 |

| Reference Books | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| **1** | ARM System Developer's Guide | Andrew N. Sloss, Dominic Symes, Chris Wright | Morgan Kaufman | 1/e, 2008 |
| **2** | Embedded System Design with Arm Cortex-M Microcontrollers | Cem Ünsalan, Hüseyin Deniz Gürhan, Mehmet Erkin Yücel | Springer | 1/e, 2022 |
| **3** | Introduction to ARM ® Cortex-M Microcontrollers | Jonathan W. Valvano | Self-Published | 5/e, 2014 |

| Video Links (NPTEL, SWAYAM…) | |
|---|---|
| **Module No.** | **Link ID** |
| **1** | https://archive.nptel.ac.in/courses/106/105/106105193/ |
| **2** | https://www.st.com/resource/en/datasheet/ |

**SEMESTER S4**

**FOUNDATIONS OF PATTERN RECOGNITION**

| | | | |
|---|---|---|---|
| **Course Code** | **24SJPEADT415** | **CIE Marks** | 40 |
| **Teaching Hours/Week (L: T:P: R)** | 3:0:0:0 | **ESE Marks** | 60 |
| **Credits** | 5/3 | **Exam Hours** | 2 Hrs. 30 Min. |
| **Prerequisites (if any)** | PCCST303 | | |

**Course Objectives:**

1. To provide a comprehensive understanding of the fundamental concepts and techniques of pattern recognition.
2. To develop the ability to apply pattern recognition methods to solve practical problems.
3. To enhance skills in using modern tools and techniques for feature extraction, dimensionality reduction, and machine learning algorithms

## SYLLABUS

| Module No. | Syllabus Description | Contact Hours |
|---|---|---|
| **1** | Introduction to Pattern Recognition - Basics of pattern recognition, Applications and examples, Statistical pattern recognition, Introduction to classifiers: k-NN, Naive Bayes<br><br>Project 1: Image Classification using k-NN and Naive Bayes - Classify images from the CIFAR-10 dataset using k-NN and Naive Bayes classifiers, and the deliverables are code implementation, project report, and presentation.<br>Assignments: Assignment on k-NN and Naive Bayes classifiers Mini-project proposal submission | **9** |
| **2** | Feature Extraction and Dimensionality Reduction - Feature selection techniques, Principal Component Analysis (PCA), Non-linear dimensionality reduction methods (t-SNE, LLE)<br><br>Project 2: Dimensionality Reduction for Handwritten Digit Recognition - Use PCA and LDA to reduce the dimensionality of the MNIST dataset and apply a classifier, and the deliverables are code implementation, project report, and presentation.<br><br>Assignments**:** Assignment on PCA and LDA theory, Mid-term project: Detailed report on feature extraction project | **9** |

| | | |
|---|---|---|
| **3** | Machine Learning Algorithms for Pattern Recognition - Support Vector Machines (SVM), Neural Networks and Deep Learning, Ensemble methods (Random Forests, Gradient Boosting), Clustering techniques (k-means, hierarchical clustering)<br><br>Project 3**:** Text Classification using SVM and Neural Networks - Classify text documents from the 20 Newsgroups dataset using SVM and a simple neural network, and the deliverables are code implementation, project report, and presentation.<br><br>Assignments: Assignment on SVM and neural network theory Group project on Ensemble methods applied to a complex dataset | **9** |
| **4** | Advanced Topics and Applications - Hidden Markov Models (HMM), Bayesian Networks, Pattern recognition in speech and handwriting.<br><br>Project 4 : Speech Recognition using Hidden Markov Models - Develop a speech recognition system using Hidden Markov Models using the dataset - TIMIT Acoustic-Phonetic Continuous Speech Corpus. The deliverables are code implementation, project report, and presentation. Tools: Python, HTK (Hidden Markov Model Toolkit).<br><br>Project 5: Handwriting Recognition using Deep Learning - Develop a handwriting recognition system using deep learning techniques using the datasets - MNIST Handwritten Digits Dataset, IAM Handwriting Database. The deliverables are code implementation, project report, and presentation. Tools: Python, TensorFlow/Keras, OpenCV.<br><br>Project 6: Bayesian Networks for Medical Diagnosis - Use Bayesian Networks to develop a system for medical diagnosis using the datasets - UCI Machine Learning Repository, Hepatitis Dataset. The deliverables are code implementation, project report, and presentation. Tools: Python, PyMC3, Netica.<br><br>Assignments:<br>Assignment on HMM and Bayesian networks<br>Final project: Comprehensive pattern recognition application | **9** |

**Course Assessment Method**
**(CIE: 40 marks, ESE: 60 marks)**

**Continuous Internal Evaluation Marks (CIE):**

| *Attendance* | *Internal Ex* | *Evaluate* | *Analyse* | *Total* |
|---|---|---|---|---|
| **5** | **15** | **10** | **10** | **40** |

***Criteria for Evaluation (Evaluate and Analyse): 20 marks***

1. **Code Implementation (40%) – 8 Marks**

- Correctness (4 Marks): Code accurately implements the required algorithms (e.g., k-NN, Naive Bayes, PCA, LDA, SVM, Neural Networks, HMM) and processes the dataset as expected. Code runs without errors and produces the expected output for different scenarios or edge cases.
- Efficiency and Robustness (4 Marks): Code is optimized for efficiency, handling large datasets or complex computations effectively, and includes error handling and can manage diverse data**.**

2. ***Results Analysis (60%) – 12 Marks***

- Valuation Metrics (6 Marks): Proper use of evaluation metrics (e.g., accuracy, precision, recall, F1 score) to assess the performance of classifiers and dimensionality reduction techniques. Comparison of different methods or classifiers and discussion on their effectiveness, including strengths and limitations.
- Insightful Analysis (6 Marks): Interpretation of the results, including any anomalies or unexpected findings. Based on results, provides thoughtful recommendations or insights for potential improvements or alternative approaches.

**End Semester Examination Marks (ESE):**

*In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions*

| Part A | Part B | Total |
|---|---|---|
| • 2 Questions from each module.<br>• Total of 8 Questions, each carrying 3 marks<br><br>**(8x3 =24 marks)** | • 2 questions will be given from each module, out of which 1 question should be answered.<br>• Each question can have a maximum of 3 sub divisions.<br>• Each question carries 9 marks.<br>**(4x9 = 36 marks)** | **60** |

**Course Outcomes (COs)**

At the end of the course students should be able to:

| Course Outcome | | Bloom's Knowledge Level (KL) |
|---|---|---|
| **CO1** | Understand and explain the fundamental concepts of pattern recognition and its applications. | **K2** |
| **CO2** | Apply statistical and machine learning techniques to solve pattern recognition problems. | **K3** |
| **CO3** | Implement feature extraction and dimensionality reduction techniques for various datasets. | **K4** |
| **CO4** | Develop and evaluate different machine learning models for pattern recognition tasks. | **K5** |
| **CO5** | Work on real-world pattern recognition projects, demonstrating problem-solving and project management skills. | **K5** |

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

**CO-PO Mapping Table:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | | | | | | | | 3 |
| **CO2** | 3 | 3 | 3 | | | | | | | | 3 |
| **CO3** | 3 | 3 | 3 | 3 | | | | | | | 3 |
| **CO4** | 3 | 3 | 3 | 3 | | | | | | | 3 |
| **CO5** | 3 | 3 | 3 | | | | 3 | | 3 | 3 | 3 |

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

| Text Books | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| **1** | Pattern Recognition and Machine Learning | Christopher M. Bishop | Springer | 1/e, 2009 |
| **2** | Mastering Machine Learning Algorithms | Giuseppe Bonaccorso | Packt Publishing | 2/e,2020 |
| **3** | Pattern Classification | Richard Duda, Peter Hart, David Stork | Wiley | 2/e, 2007 |
| **4** | Deep Learning | Ian Goodfellow, Yoshua Bengio, and Aaron Courville | McGraw-Hill | 1/e, 1997 |
| **5** | Feature Extraction and Image Processing for Computer Vision | Mark Nixon and Alberto Aguado | Academic Press | 3/e, 2012 |

| Reference Books | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| **1** | The Nature of Statistical Learning Theory | Vladimir Vapnik | Springer-Verlag New York Inc. | 2/e, 2010 |
| **2** | The Elements of Statistical Learning | Jerome Friedman, Robert Tibshirani, Trevor Hastie | Springer-Verlag New York Inc | 9/e, 2017 |
| **3** | Pattern Recognition | S.Theodoridis and K.Koutroumbas | Academic Press | 4/e, 2009 |

| Video Links (NPTEL, SWAYAM…) | |
|---|---|
| **Module No.** | **Link ID** |
| **1** | https://archive.nptel.ac.in/courses/117/105/117105101/ |
| **2** | https://archive.nptel.ac.in/courses/117/105/117105101/ |
| **3** | https://archive.nptel.ac.in/courses/117/105/117105101/ |
| **4** | https://archive.nptel.ac.in/courses/117/105/117105101/ |

# Programme Outcomes (POs)

**PO1: Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

**PO2: Problem analysis:** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using the first principles of mathematics, natural sciences, and engineering sciences.

**PO3: Design/development of solutions:** Design solutions for complex engineering problems and system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

**PO4: Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

**PO5: Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

**PO6: The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

**PO7: Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

**PO8: Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multi-disciplinary settings.

**PO09: Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

**PO10: Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multi-disciplinary environments.

**PO11: Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

# ST. JOSEPH'S
## COLLEGE OF ENGINEERING AND TECHNOLOGY, - PALAI -
## AUTONOMOUS

## VISION

Developing into a world class, pace setting institute of Engineering and Technology with distinct identity and character, meeting the goals and aspirations of the society.

## MISSION

- To maintain a conducive infrastructure and learning environment for world class education.
- To nurture a team of dedicated, competent and research-oriented faculty.
- To develop students with moral and ethical values, for their successful careers, by offering variety of programs and services.