**KG COLLEGE OF ARTS AND SCIENCE**
Autonomous Institution | Affiliated to Bharathiar University
Accredited with A++ Grade by NAAC
ISO 9001:2015 Certified Institution
KGiSL Campus, Saravanampatti, Coimbatore – 641 035

# Regulations 2025-26 for Postgraduate Programme

**Learning Outcomes Based Curriculum Framework (LOCF) model with
Choice Based Credit System (CBCS)**

**Programme: M.Sc. Computer Science (M.Sc. CS)
Programme Code: MCS**

**(Applicable for the Students admitted during the Academic Year 2025-26 onwards)**

## Eligibility

The student should have passed B.Sc. Computer Science / BCA / B.Sc. Computer Science related Courses / B.E. / B.Tech. Computer Science related course is eligible for M.Sc. Computer Science. (As per the eligibility condition given by Bharathiar University Ref. BU/R/B3-B4/ Eligibility Condition /2025/7960 dated 08/05/2025).

## Program Learning Outcomes (PLOs)

The successful completion of the M.Sc. Computer Science programme shall enable the students to:

| | |
|---|---|
| PLO1 | Develop critical analysis with creativity and problem solving skills in Computational Science to become Data Scientist and Data Analyst. |
| PLO2 | Exhibit research skills, design and critical thinking to embellish the career of computer System Analyst, Software Engineer and Scientific Researcher to solve real world problem. |
| PLO3 | Continue the process of life-long learning through professional activities and adapt themselves persuasively in Full Stack Development, AI and Cloud Computing. |
| PLO4 | Enhance skills for effective leadership in IT support, Network Architect, Web Development and successful entrepreneur as well. |
| PLO5 | Apply ethical principles through human computer interaction and contribute effectively to the welfare of the society. |

## M.Sc. Computer Science
## Distribution of Credits and Hours for all the Semesters

| Part | Course Category | No. of Courses | Hours | | Credits | Total Credits | | Semester |
|------|-----------------|----------------|-------|---|---------|---------------|---|----------|
| III | Core Theory (6 hrs. /week) | 2 | 2 X 6 | 12 | 4 | 8 | | 3 |
| | Core Theory (5 hrs. /week) | 2 | 2 X 5 | 10 | 4 | 8 | | 2 |
| | Core Theory (4 hrs. /week) | 5 | 5 X 4 | 20 | 4 | 20 | | 1 - 2 |
| | Core Practical (4 hrs. / week) | 5 | 5 X 4 | 20 | 3 | 15 | | 1 - 2 |
| | Core:Embedded Lab(7 hrs./week) | 1 | 1 X 7 | 7 | 5 | 5 | 84 | 3 |
| | Elective Theory (5 hrs. / week) | 1 | 1 X 5 | 5 | 4 | 4 | | 3 |
| | Elective Theory (4 hrs. / week) | 2 | 2 X 4 | 8 | 4 | 8 | | 1 - 2 |
| | Skill Enhancement Course (SEC) Lab | 2 | 2 X 2 | 4 | 3 | 6 | | 2 - 3 |
| | Internship | 1 | - | - | 2 | 2 | | 3 |
| | Project Work | 1 | - | - | 8 | 8 | | 4 |
| IV | Ability Enhancement Compulsory Course (AECC) | 2 | 2 X 2 | 4 | 2 | 4 | 6 | 1 - 2 |
| | Ability Enhancement Compulsory Course (AECC) – Online Course MOOC | 1 | - | - | 2 | 2 | | 3 |
| | **Total** | **25** | | **90** | | **90** | **90** | |

## Consolidated Semester wise and Component wise
## Hours and Credits Distribution

| Semester | Part III | | Part IV | | Total | |
|----------|----------|---------|---------|---------|-------|---------|
| | Hours | Credits | Hours | Credits | Hours | Credits |
| 1 | 28 | 26 | 2 | 2 | 30 | **28** |
| 2 | 28 | 25 | 2 | 2 | 30 | **27** |
| 3 | 30 | 25 | - | 2 | 30 | **27** |
| 4 | - | 08 | - | - | - | **08** |
| Total | 86 | 84 | 4 | 6 | 90 | 90 |

# Curriculum

# M.Sc. Computer Science

| Semester – 1 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Course Code** | **Part** | **Course Category** | **Course Name** | **Hours / Week** | **Examination** | | | | **Credits** |
| | | | | | **Duration in Hours** | **Max Marks** | | | |
| | | | | | | **CIA** | **ESE** | **Total** | |
| 25MCS11C | III | Core – I | Analysis and Design of Algorithms | 4 | 3 | 25 | 75 | 100 | 4 |
| 25MCS12C | III | Core - II | Python Programming | 4 | 3 | 25 | 75 | 100 | 4 |
| 25MCS13P | III | Core Lab - I | Python Programming Lab | 4 | 3 | 40 | 60 | 100 | 3 |
| 25MCS14C | III | Core – III | MongoDB | 4 | 3 | 25 | 75 | 100 | 4 |
| 25MCS15P | III | Core Lab - II | MongoDB Lab | 4 | 3 | 40 | 60 | 100 | 3 |
| 25MCS16C | III | Core - IV | Advanced Operating System | 4 | 3 | 25 | 75 | 100 | 4 |
| 25MCS1AE | III | Elective - I | Exploratory Data Analysis | 4 | 3 | 25 | 75 | 100 | 4 |
| 25MCS1BE | III | | Blockchain Technology and Applications | | | | | | |
| 25MCS1CE | III | | Data Preprocessing and Visualization | | | | | | |
| 25SOF1AE | IV | AECC - I | Soft Skills | 2 | 2 | - | 50 | 50 | 2 |
| **Total** | | | | **30** | | | | **750** | **28** |

| Course Code | Part | Course Category | Course Name | Hours / Week | Duration in Hours | Max Marks | | | Credits |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | CIA | ESE | Total | |
| 25MCS21C | III | Core - V | Advanced Java Programming | 5 | 3 | 25 | 75 | 100 | 4 |
| 25MCS22P | III | Core Lab- III | Advanced Java Programming Lab | 4 | 3 | 40 | 60 | 100 | 3 |
| 25MCS23C | III | Core - VI | Artificial Intelligence and Machine Learning | 5 | 3 | 25 | 75 | 100 | 4 |
| 25MCS24P | III | Core Lab- IV | Artificial Intelligence and Machine Learning Lab | 4 | 3 | 40 | 60 | 100 | 3 |
| 25MCS25C | III | Core - VII | Data Mining | 4 | 3 | 25 | 75 | 100 | 4 |
| 25MCS2AE | III | Elective - II | Big Data Analytics | 4 | 3 | 25 | 75 | 100 | 4 |
| 25MCS2BE | III | | Ethical Hacking | | | | | | |
| 25MCS2CE | III | | Neural Networks and Deep Learning | | | | | | |
| 25MCS26P | III | SEC Lab - I | Data Mining Lab | 2 | 3 | 40 | 60 | 100 | 3 |
| 25QUA2AE | IV | AECC - II | Quantitative Aptitude | 2 | 2 | - | 50 | 50 | 2 |
| **Total** | | | | **30** | | | | **750** | **27** |

**Semester – 2**

| | | | **Semester – 3** | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Course Code** | **Part** | **Course Category** | **Course Name** | **Hours / Week** | **Examination** | | | | **Credits** |
| | | | | | **Duration in Hours** | **Max Marks** | | | |
| | | | | | | **CIA** | **ESE** | **Total** | |
| | III | Core - VIII | Digital Image Processing | 6 | 3 | 25 | 75 | 100 | 4 |
| | III | Core - IX | Network Security and Cryptography | 6 | 3 | 25 | 75 | 100 | 4 |
| | III | Embedded | (**Embedded**): Cloud Computing Lab | 3 + 4 | 3 | 40 | 60 | 100 | 5 |
| | III | Core Lab- V | Web Application Development and Hosting Lab | 4 | 3 | 40 | 60 | 100 | 3 |
| | III | Elective - III | Social Network Analytics | 5 | 3 | 25 | 75 | 100 | 4 |
| | III | | Digital and Mobile Forensics | | | | | | |
| | III | | Generative AI and Prompt Engineering | | | | | | |
| | III | SEC Lab - II | Digital Image Processing Lab | 2 | 3 | 40 | 60 | 100 | 3 |
| | III | Internship | Internship | - | - | 50 | - | 50 | 2 |
| | IV | AECC - III | Online Course MOOC | - | - | 50 | - | 50 | 2 |
| **Total** | | | | **30** | | | | **700** | **27** |

| | | | **Semester – 4** | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Course Code** | **Part** | **Course Category** | **Course Name** | **Hours / Week** | **Examination** | | | | **Credits** |
| | | | | | **Duration in Hours** | **Max Marks** | | | |
| | | | | | | **CIA** | **ESE** | **Total** | |
| | III | Core: Project | Project Work | - | - | 100 | 100 | 200 | 8 |
| **Total** | | | | **-** | **-** | | | **200** | **8** |
| **Grand Total** | | | | **90** | | | | **2400** | **90** |

# Semester - 1

| | | | | | | Examination | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Semester – 1** | | | | | | | | | |
| **Course Code** | **Part** | **Course Category** | **Course Name** | **Hours / Week** | **Duration in hrs.** | **Max Marks** | | | **Credits** |
| | | | | | | **CIA** | **ESE** | **Total** | |
| 25MCS11C | III | Core – I | Analysis and Design of Algorithms | 4 | 3 | 25 | 75 | 100 | 4 |
| 25MCS12C | III | Core - II | Python Programming | 4 | 3 | 25 | 75 | 100 | 4 |
| 25MCS13P | III | Core Lab - I | Python Programming Lab | 4 | 3 | 40 | 60 | 100 | 3 |
| 25MCS14C | III | Core – III | MongoDB | 4 | 3 | 25 | 75 | 100 | 4 |
| 25MCS15P | III | Core Lab - II | MongoDB Lab | 4 | 3 | 40 | 60 | 100 | 3 |
| 25MCS16C | III | Core - IV | Advanced Operating System | 4 | 3 | 25 | 75 | 100 | 4 |
| 25MCS1AE | III | Elective - I | Exploratory Data Analysis | 4 | 3 | 25 | 75 | 100 | 4 |
| 25MCS1BE | III | | Blockchain Technology and Applications | | | | | | |
| 25MCS1CE | III | | Data Preprocessing and Visualization | | | | | | |
| 25SOF1AE | IV | AECC - I | Soft Skills | 2 | 2 | - | 50 | 50 | 2 |
| **Total** | | | | **30** | | | | **750** | **28** |

| Course Code | Course Name | Category | Hours / Week | Credits |
|---|---|---|---|---|
| **25MCS11C** | **Analysis and Design of Algorithms** | **Core – I** | **4** | **4** |

## Course Objectives

The course intends to cover
- Elementary data structures.
- Various techniques such as divide and conquer, dynamic programming, backtracking.

## Course Learning Outcomes

On the successful completion of the course, students will be able to

| CLO | CLO Statements | Knowledge Level |
|---|---|---|
| CLO1 | Recite the elementary data structures. | K1 |
| CLO2 | Understand the traversal and search techniques. | K2 |
| CLO3 | Apply the Greedy method in various applications. | K3 |
| CLO4 | Analyze the dynamic programming techniques. | K4 |
| CLO5 | Evaluate the concept of backtracking, branch and bound techniques. | K5 |
| **K1** – Remember; **K2** – Understand; **K3** – Apply; **K4** – Analyze; **K5** – Evaluate ||||

## CLO – PLO Mapping

| CLOs/PLOs | PLO1 | PLO2 | PLO3 | PLO4 | PLO5 |
|---|---|---|---|---|---|
| CLO1 | 2 | 3 | 2 | 3 | 3 |
| CLO2 | 2 | 2 | 2 | 3 | 2 |
| CLO3 | 2 | 2 | 2 | 2 | 2 |
| CLO4 | 3 | 3 | 2 | 2 | 2 |
| CLO5 | 3 | 3 | 3 | 3 | 2 |
| 3 - Substantial (high) || 2 - Moderate (medium) || 1 - Slight (low) ||

**Department of Computer Science[PG]**

# Core - I:  Analysis and Design of Algorithms

| Unit | Content | No. of Hours |
|------|---------|--------------|
| I | **Introduction:** Algorithm Definition and Specification – Space complexity-Time Complexity- Asymptotic Notations - Elementary Data Structure: Stacks and Queues – Binary Tree - Binary Search Tree - Heap – Heap sort- Graph. | 12 |
| II | **Traversal and search techniques:** Basics of Traversal and Search Techniques-Techniques for Binary Trees-Techniques for Graphs -Divide and Conquer: - General Method – Binary Search – Merge Sort – Quick Sort. | 13 |
| III | **Greedy method:** General Method –Knapsack Problem – Minimum Cost Spanning Tree – Single Source Shortest Path. | 11 |
| IV | **Dynamic Programming:** General Method –Multistage Graphs – All Pair Shortest Path–Optimal Binary Search Trees – 0/1 Knapsacks – Traveling Salesman Problem – Flow Shop Scheduling. | 13 |
| V | **Backtracking:** General Method–8-QueensProblem–Sum of Subsets – Graph Coloring– Hamiltonian Cycles – Branch and Bound:  The Method – Traveling Salesperson. | 11 |
| | **Total  Hours** | **60** |

**Text Books**

| 1 | Alfred V. Aho, John E. Hopcroft, Jeffrey D. Ullman, (2013), Data Structures and  Algorithms, Pearson Education Limited. |
|---|---|
| 2 | Ellis Horowitz (2008), Computer Algorithms, Galgotia Publications. |

**Reference Books**

| 1 | Marcello La Rocca, (2021), Advanced Algorithms and Data Structures, 1$^{st}$ Edition, Manning Publications. |
|---|---|
| 2 | Goodrich, (2022), Data Structures and Algorithms in Java, 6$^{th}$ Edition, Wiley. |
| 3 | Skiena, (2008), The Algorithm Design Manual, 2$^{nd}$ Edition, Springer. |
| 4 | Anany Levith, (2003), Introduction to the Design and Analysis of algorithm, Pearson  Education Asia. |
| 5 | Robert Sedgewick, Phillipe Flajolet (1996), An Introduction to the Analysis of  Algorithms, Addison-Wesley Publishing Company. |

**Web Resources (Swayam / NPTEL)**

| 1 | https://onlinecourses.nptel.ac.in/noc24_cs23/preview |
|---|---|
| 2 | https://onlinecourses.nptel.ac.in/noc24_cs28/preview |
| 3 | https://onlinecourses.nptel.ac.in/noc24_cs45/preview |

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| Course Code | Course Name | Category | Hours / Week | Credits |
|---|---|---|---|---|
| **25MCS12C** | **Python Programming** | **Core - II** | **4** | **4** |

## Course Objectives

The course intends to cover
- Elementary data structures of Python programming.
- Modules to perform specific task.
- Python libraries and frameworks for rapid application development.

## Course Learning Outcomes

On the successful completion of the course, students will be able to

| CLO | CLO Statements | Knowledge Level |
|---|---|---|
| CLO1 | Recite the basic concepts of Python. | K1 |
| CLO2 | Understand the Object-Oriented concepts and modules in Python. | K2 |
| CLO3 | Analyze the data storage, databases, web and network applications. | K4 |
| CLO4 | Build real time applications using Python libraries. | K3 |
| CLO5 | Create an application in Python using frameworks Flask and Django. | K6 |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** – Analyze; **K6** - Create | | |

## CLO – PLO Mapping

| CLOs/PLOs | PLO1 | PLO2 | PLO3 | PLO4 | PLO5 |
|---|---|---|---|---|---|
| CLO1 | 2 | 2 | 3 | - | 3 |
| CLO2 | 2 | 3 | 3 | - | 3 |
| CLO3 | 2 | 3 | 3 | - | 3 |
| CLO4 | 3 | 3 | 3 | 1 | 3 |
| CLO5 | 3 | 3 | 3 | 1 | 3 |
| **3** - Substantial (high) | | **2** - Moderate (medium) | | **1** - Slight (low) | |

## Core – II : Python Programming

| Unit | Content | No. of Hours |
|------|---------|--------------|
| I | **Introduction**: Numbers – Strings – Variables – Lists – Tuples – Dictionaries – Sets– Comparison. **Code Structures:** if, elif, and else – Repeat with while – Iterate with for – Comprehensions – Functions – Generators – Decorators – Namespaces and Scope – Handle Errors with try and except – User Exceptions. | 12 |
| II | **Modules and Programs:** Standalone Programs – Command-Line Arguments – Modules and the import Statement – The Python Standard Library. Objects and Classes: Define a Class – Inheritance – Override a Method – Add a Method – Get and Set Attribute Values with Properties –- Method Types– Special Methods. | 10 |
| III | **Storing and Retrieving Data**: File Input/Output – Structured Text Files – Structured Binary Files. Database Programming using Python: Connecting to a database (sqlite, mysql) using Python, Sending DML and DDL queries and processing the result from the Python Program. Web: Web Clients – Web Servers – Web Services and Automation. Networks: Patterns – The Publish-Subscribe Model – TCP/IP – Sockets – Web Services and APIs. | 13 |
| IV | **NumPy**: Operations using NumPy - NumPy for Arrays - Data Type Objects (dtype) – NumPy Mathematical Operations. Pandas: Key Features of Pandas – Pandas data structures – series and DataFrame – Loading a dataset into a dataframe – Selecting columns and rows from dataframe – Adding new data and deleting data from a dataframe. Matplotlib: Use of Matplotlib – Types of Plots –Working with multiple Plots. | 12 |
| V | **Python Frameworks:** Frameworks - Types of Python Frameworks - Flask: Introduction to Flask - Installation - Basic Application Structure - Initialization - Routes and views function - Server startup - A Complete application - The Request-Response cycle. Django: Install Django – Web frameworks – The development server – Model-view-controller vs Model view template -   Initial Setup - First Django project – Create an app – URL confs – Pages app. | 13 |
| | **Total Hours** | **60** |

### Text Books

| | |
|---|---|
| 1 | Jameer Basha A, Lokesh S and Kiruba B (2024), Python Programming, 3rd Impression, Pearson Publications. |
| 2 | Yashvant Kanetkar, Aditya Kanetkar (2023), Let us Python, 6th Edition, BPB Publications. |
| 3 | Bill Lubanovic (2014), Introducing Python, 1st Edition-Second Release, O'Reilly Media Publisher. |
| 4 | William S Vincent (2020), Django for beginners Build websites with python & Django,  2020 Edition, WelcomeToCode publisher. |
| 5 | Malhar Lathkar (2021), Building Web Apps with Python and Flask, 2021 Edition, BPB Publications. |

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| **Reference Books** | |
|---|---|
| 1 | Alex Martelli, Anna Ravenscroft, Steve Holden (2017), Python in Nutshell, 3rd Edition, O'Reilly Media Publisher. |
| 2 | Sheetal Taneja, Naveen Kumar (2017), Python Programming – A Modular Approach, Pearson Publications. |
| 3 | Antonio Mele (2020), Django by Example Build Powerful and reliable python web applications from scratch, 3rd Edition, Packt Publications. |
| 4 | Shalabh Aggarwal (2019), Flask Framework cookbook, 2nd Edition, Packt Publications. |
| **Web Resources (Swayam / NPTEL)** | |
| 1 | https://onlinecourses.nptel.ac.in/noc24_cs54/preview |
| 2 | https://onlinecourses.swayam2.ac.in/aic20_sp33/preview |
| 3 | https://onlinecourses.swayam2.ac.in/cec22_cs20/preview |
| 4 | https://onlinecourses.swayam2.ac.in/cec24_cs03/preview |

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| Course Code | Course Name | Category | Hours / Week | Credits |
|---|---|---|---|---|
| 25MCS13P | Python Programming Lab | Core Lab – I | 4 | 3 |

| S. No. | List of Programs |
|---|---|
| 1 | Elementary programs in Python. |
| 2 | Programs to implement Lists, Dictionaries, Tuples and Sets. |
| 3 | Implement conditional structures and loops. |
| 4 | Demonstrate Python programs using modules. |
| 5 | Programs to implement file operations. |
| 6 | Implement database connectivity, execute DDL and DML queries. |
| 7 | Programs using NumPy library. |
| 8 | Programs using Pandas library. |
| 9 | Develop a various charts using Matplotlib library. |
| 10 | Design a multipage website using flask. |
| 11 | Design a simple form using Django. |
| | **Total Hours**    **60** |

**Text Books**

| 1 | Yashvant Kanetkar, Aditya Kanetkar, (2023), Let us Python, 6th Edition, BPB Publications. |
|---|---|
| 2 | Bill Lubanovic, (2014), Introducing Python, 1st Edition-Second Release, O'Reilly Media Publisher. |

**Reference Books**

| 1 | Alex Martelli, Anna Ravenscroft, Steve Holden, (2017), Python in Nutshell, 3rd Edition, O'Reilly Media Publisher. |
|---|---|
| 2 | Sheetal Taneja, Naveen Kumar, (2017), Python Programming – A Modular Approach, Pearson Publications. |
| 3 | Antonio Mele, (2020), Django by Example Build Powerful and reliable python web applications from scratch, 3rd Edition, Packt Publications. |
| 4 | Shalabh Aggarwal, (2019), Flask Framework cookbook, 2nd Edition, Packt Publications. |

**Web Resources (Swayam / NPTEL)**

| 1 | https://onlinecourses.nptel.ac.in/noc24_cs54/preview |
|---|---|
| 2 | https://onlinecourses.swayam2.ac.in/aic20_sp33/preview |
| 3 | https://onlinecourses.swayam2.ac.in/cec22_cs20/preview |
| 4 | https://onlinecourses.swayam2.ac.in/cec24_cs03/preview |

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| Course Code | Course Name | Category | Hours / Week | Credits |
|---|---|---|---|---|
| 25MCS14C | MongoDB | Core - III | 4 | 4 |

## Course Objectives

The course intends to cover

- MongoDB fundamentals such as databases, collections and CRUD operations.
- Indexing strategies to improve query performance.

## Course Learning Outcomes

On the successful completion of the course, students will be able to

| CLO | CLO Statements | Knowledge Level |
|---|---|---|
| CLO1 | Understand NoSQL Database and differences with RDBMS and CAP Theorem. | K1, K2 |
| CLO2 | Apply data modelling and schema validation. | K3 |
| CLO3 | Analyze the requirement and design the MongoDB documents and collections. | K4 |
| CLO4 | Understand the aggregation operators in MongoDB. | K2 |
| CLO5 | Create Shards in MongoDB. | K6 |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** – Analyze; **K6** - Create | | |

## CLO-PLO Mapping

| CLOs/PLOs | PLO1 | PLO2 | PLO3 | PLO4 | PLO5 |
|---|---|---|---|---|---|
| CLO1 | 2 | 3 | 3 | 2 | 2 |
| CLO2 | 3 | 3 | 3 | 2 | 3 |
| CLO3 | 3 | 3 | 3 | 3 | 3 |
| CLO4 | 2 | 3 | 3 | 2 | 2 |
| CLO5 | 3 | 3 | 3 | 3 | 2 |
| 3 - Substantial (high) | | 2 - Moderate (medium) | | 1 - Slight (low) | |

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## Core - III : MongoDB

| Unit | Content | No. of Hours |
|---|---|---|
| I | **Introduction to NoSQL:** Types of NoSQL Databases – MongoDB – Differences between MongoDB and RDBMS – CAP theorem – JSON – BSON – MongoDB document. | 10 |
| II | **MongoDB Installation and Data Modeling:** Databases and collections- Introduction to MongoDB shell-Configuring MongoDB shell-Accessing the MongoDB shell-Understanding data types - MongoDB data modeling-Embedded data model-References data model-Perform schema validations. | 12 |
| III | **CRUD Operations:** Introduction to CRUD operations - creating databases and collections-Insert operation-Ready operation-Update operation- Delete operation. Additional CRUD Related Methods: Overview of CRUD methods - insert() method - update()method - find()method - findOneandDelete()method-findOneAndReplace() method -findOneAndUpdate() method - findAndModify() method. | 10 |
| IV | **Aggregation:** Aggregation operators-Aggregation stage operators-Expression operators: Expression arithmetic operators- Set expression and array operators-Expression boolean operators - Expression comparison operators- Expression date operators- Expression string operators. | 12 |
| V | **Indexes and Performance Tuning:** Different types of Indexes-Index Creation- listing the indexes - Default_Id index-Drop an Index-Single Field Index -Compound Index. Introduction to Storage and Storage Engine: WiredTiger/In -Memory Storage Engine. Introduction to MongoDB Sharding: Advantages of sharding- Architecture overview-development, continuous deployment and staging environments-Planning ahead on sharding – Shard key – Choosing a Shard key. MongoDB with Web Framework: Django and MongoDB. | 16 |
| | **Total Hours** | **60** |

**Text Books**

| 1 | Kristina Chodorow (2013), MongoDB: The Definitive Guide. |
|---|---|
| 2 | Amit Phaltankar, Juned Ahsan,Michael Harrison,Liviu Nedov (2020), MongoDB Fundamentals: A hands-on guide to using MongoDB and Atlas in the real world, Packt Publishing. |
| 3 | Niall O'Higgins, (2011), MongoDB and Python: Patterns and Processes for the Popular Document-oriented Database, O'Reilly. |

**Reference Books**

| 1 | Manu Sharma (2021), MongoDB Complete Guide, BPB Publication. |
|---|---|
| 2 | Alex Giamas (2017), Mastering MongoDB 3.x, Packt Publishing Ltd. |

**Web Resources (Swayam / NPTEL)**

| 1 | https://nptel.ac.in/courses/106104135 |
|---|---|

| Course Code | Course Name | Category | Hours / Week | Credits |
|---|---|---|---|---|
| **25MCS15P** | **MongoDB  Lab** | **Core Lab - II** | **4** | **3** |

| S. No. | List of Programs |
|---|---|
| 1 | Basic operations in MongoDB. |
| 2 | Build a database in MongoDB. |
| 3 | Create MongoDB Database with Employee Collection, having Employee ID, Employee Name, Department, Salary, Deductions, Gross and NetSalary. |
| 4 | Model collections in different perspective of Employee collection/ Department collection. |
| 5 | Perform Schema Validations -Validate Schema of inserted documents, whether minimum expected schema is matched. |
| 6 | Perform Read operations based on specific conditions. |
| 7 | Perform insertion, deletion, updating documents based on conditions to the collection. |
| 8 | Perform aggregations using various operators. |
| 9 | Add appropriate single field and multiple field index. |
| 10 | Perform aggregations on documents based on criteria. |
| 11 | Update Document using: a) update() method  b) save() method. |
| 12 | MongoDB Projection. |
| 13 | Perform limit(), skip() and sort() methods in MongoDB. |
| 14 | MongoDB string expression and array update operators. |
| 15 | Student database creation using MongoDB with Python. |
| | **Total Hours**  \| **60** |

**Text Books**

| 1 | Amit Phaltankar, Juned Ahsan, Michael Harrison, Liviu Nedov, (2020), MongoDB Fundamentals: A hands-on guide to using MongoDB and Atlas in the real world, Packt Publishing. |
|---|---|
| 2 | Kristina Chodoro, (2013), MongoDB: The Definitive Guide. |
| 3 | Niall O'Higgins, (2011), MongoDB and Python: Patterns and Processes for the Popular Document-oriented Database, O'Reilly. |

**Reference Books**

| 1 | Manu Sharma, (2021), MongoDB Complete Guide, BPB Publication. |
|---|---|
| 2 | Alex Giama, (2017), Mastering MongoDB 3.x, Packt Publishing Ltd. |

**Web Resources (Swayam / NPTEL)**

| 1 | https://nptel.ac.in/courses/106104135 |
|---|---|

**Department of Computer Science[PG]**

| Course Code | Course Name | Category | Hours / Week | Credits |
|---|---|---|---|---|
| **25MCS16C** | **Advanced Operating System** | **Core - IV** | **4** | **4** |

## Course Objectives

The course intends to cover

- Different types of operating systems and their functions.
- Components and management aspects of real time and mobile OS.

## Course Learning Outcomes

On the successful completion of the course, students will be able to

| CLO | CLO Statements | Knowledge Level |
|---|---|---|
| CLO1 | Recite the different kinds of operating systems and process scheduling. | K1 |
| CLO2 | Understand the design issues associated with distributed operating system. | K2 |
| CLO3 | Interpret the concepts of real time operating system and task scheduling. | K2 |
| CLO4 | Explore the operating systems for handheld systems. | K4 |
| CLO5 | Analyze operating systems like LINUX and iOS. | K4 |
| **K1** – Remember; **K2** – Understand; **K4** – Analyze |||

## CLO-PLO Mapping

| CLOs/PLOs | PLO1 | PLO2 | PLO3 | PLO4 | PLO5 |
|---|---|---|---|---|---|
| CLO1 | 2 | 3 | 3 | 1 | 2 |
| CLO2 | 3 | 3 | 3 | 2 | 2 |
| CLO3 | 3 | 3 | 3 | 3 | 3 |
| CLO4 | 3 | 3 | 3 | 3 | 3 |
| CLO5 | 2 | 3 | 2 | 2 | 2 |
| 3 - Substantial (high) | | 2 - Moderate (medium) | | 1 - Slight (low) | |

# Core - IV : Advanced Operating System

| Unit | Content | No. of Hours |
|---|---|---|
| I | **Basics of Operating Systems:** Operating System Overview – Main frame Systems – Desktop Systems – Multiprocessor Systems – Distributed Systems – Clustered Systems – Real-Time Systems – Handheld Systems – Feature Migration – Computing Environments -Process Scheduling – Cooperating Processes – Inter Process Communication- Deadlocks –Prevention – Avoidance – Detection – Recovery. | 14 |
| II | **Distributed Operating Systems:** Issues – Communication Primitives – Lamport's Logical Clocks – Deadlock handling strategies – Issues in deadlock detection and resolution-distributed file systems –design issues – Case studies – The Sun Network File System-Coda. | 12 |
| III | **Real Time Operating System :** Introduction – Applications of Real Time Systems – Basic Model of Real Time System – Characteristics – Safety and Reliability - Real Time Task Scheduling | 10 |
| IV | **Operating Systems for Handheld Systems:** Requirements –Technology – Overview– Handheld Operating Systems –Palm OS-Symbian Operating System Android – Architecture of android – Securing Handheld systems. | 12 |
| V | **Case Studies:** Linux System: Introduction – Memory Management – Process Scheduling – Scheduling Policy - Managing I/O devices – Accessing Files- iOS: Architecture and SDK Framework - Media Layer - Services Layer - Core OS Layer - File System. | 12 |
| | **Total Hours** | **60** |

**Text Books**

| 1. | Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, (2013), Operating System Concepts, 9th Edition, John Wiley & Sons. |
|---|---|
| 2. | Mukesh Singhal and Niranjan G. Shivaratri, (2001), Advanced Concepts in Operating Systems – Distributed, Database, and Multiprocessor Operating Systems, 2nd Edition Tata McGraw-Hill. |

**Reference Books**

| 1 | Neil Smyth (2011), iPhone iOS 4 Development Essentials–Xcode, 4th Edition, Payload media. |
|---|---|
| 2 | Pramod Chandra P. Bhatt (2010), An introduction to operating systems, concept and practice, 3rd Edition, PHI. |
| 3 | Daniel.P Bovet and Marco Cesati (2005), Understanding the Linux Kernel, 3rd Edition. |
| 4 | Rajib Mall (2006), Real-Time Systems: Theory and Practice, Pearson Education India. |

**Web Resources (Swayam / NPTEL)**

| 1 | https://onlinecourses.nptel.ac.in/noc20_cs04/preview |
|---|---|

| Course Code | Course Name | Category | Hours / Week | Credits |
|---|---|---|---|---|
| **25MCS1AE** | **Exploratory Data Analysis** | **Elective - I** | **4** | **4** |

## Course Objectives

The course intends to cover
- Methods for data preparation and data understanding.
- Techniques such as correlation analysis, time series and dimensionality reductions.

## Course Learning Outcomes

On the successful completion of the course, students will be able to

| CLO | CLO Statements | Knowledge Level |
|---|---|---|
| CLO1 | Understand missing data in the real-world data sets by choosing appropriate methods. | K1, K2 |
| CLO2 | Apply the data transformation techniques. | K3 |
| CLO3 | Analyze the correlation and time series. | K4 |
| CLO4 | Explain the importance of clustering algorithms and outlier detection. | K5 |
| CLO5 | Evaluate dimensionality reduction and model development. | K5 |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate | | |

## CLO-PLO Mapping

| CLOs/PLOs | PLO1 | PLO2 | PLO3 | PLO4 | PLO5 |
|---|---|---|---|---|---|
| CLO1 | 3 | 2 | 3 | 3 | 3 |
| CLO2 | 3 | 3 | 2 | - | 3 |
| CLO3 | 3 | 3 | 3 | - | 2 |
| CLO4 | 2 | 2 | 3 | 2 | 3 |
| CLO5 | 3 | 3 | 3 | 3 | 3 |
| 3 - Substantial (high) | | 2 - Moderate (medium) | | 1 - Slight (low) | |

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# Elective - I : Exploratory Data Analysis

| Unit | Content | No. of Hours |
|------|---------|--------------|
| I | **Introduction to Exploratory Data Analysis:** Steps in EDA, Data Types, Numerical Data – Discrete data, continuous data – Categorical data – Measurement Scales: Nominal, Ordinal, Interval, Ratio – Comparing EDA with classical and Bayesian Analysis – Software tools for EDA. | 10 |
| II | **Data Transformation:** Transformation Techniques: Performing data deduplication - replacing values – Discretization and binning. Introduction to Missing data, handling missing data: Traditional methods - Maximum Likelihood Estimation | 10 |
| III | **Correlation Analysis and Time Series Analysis:** Types of analysis: Univariate analysis - bivariate analysis - multivariate analysis. Time Series Analysis (TSA): Fundamentals of TSA - characteristics of TSA – Time based indexing - visualizing time series – grouping time series data - resampling time series data. | 12 |
| IV | **Clustering Algorithms:** Introduction to Spectral clustering – Document clustering – Minimum Spanning Tree clustering. Overview of Model-based clustering – Expectation-Maximization algorithm – Hierarchical Agglomerative model-based clustering. Outlier detection using Clustering. | 12 |
| V | **Dimensionality Reduction:** Linear Methods: Principal Component Analysis (PCA) – Singular Value Decomposition – Factor Analysis -Intrinsic Dimensionality. Non Linear methods: Multidimensional Scaling – Manifold Learning – Self-Organizing Maps. Model Development and Evaluation: Constructing linear regression model – evaluation – computing accuracy – understanding accuracy. Understanding reinforcement learning: Difference between supervised and reinforcement learning – Applications of reinforcement learning. | 16 |
| | **Total Hours** | **60** |

## Text Books

| 1. | Suresh Kumar Mukhiya, Usman Ahmed, (2020), Hands-On Exploratory Data Analysis with Python, 1st Edition, Packt Publishing. |
|----|----|
| 2. | Martinez, W, Martinez A & J.L. Solka (2017), Exploratory Data Analysis with MATLAB, 3rd Edition, CRC Press, A Chapman & Hall Book. |

## Reference Books

| 1. | Charu C. Aggarwal (2015), Data Mining the Textbook, Springer. |
|----|----|
| 2. | Craig K. Enders (2010), Applied Missing Data Analysis, 1st Edition, The Guilford Press. |
| 3. | Michael Jambu (1991), Exploratory and multivariate data analysis, 1st Edition, Academic Press Inc. |

## Web Resources  (Swayam / NPTEL)

| 1. | https://nptel.ac.in/courses/109107190 |
|----|----|

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| Course Code | Course Name | Category | Hours / Week | Credits |
|---|---|---|---|---|
| **25MCS1BE** | **Blockchain Technology and Applications** | **Elective - I** | **4** | **4** |

## Course Objectives

The course intends to cover
- Fundamentals of blockchain and crypto currency.
- Blockchain security features and its significance.
- Problems and challenges in blockchain

## Course Learning Outcomes

On the successful completion of the course, students will be able to

| CLO | CLO Statements | Knowledge Level |
|---|---|---|
| CLO1 | Reminisce blockchain technology and understand crypto currency. | K1, K2 |
| CLO2 | Understand the mining mechanism in blockchain. | K2 |
| CLO3 | Apply the Cryptocurrency and trust model. | K3 |
| CLO4 | Interpret the Crypto economics and Cryptocurrency regulations. | K2 |
| CLO5 | Analyze the challenges and opportunities in blockchain. | K4 |
| **K1** - Remember;  **K2** - Understand;  **K3** - Apply;  **K4** - Analyze | | |

## CLO – PLO Mapping

| CLOs/PLOs | PLO1 | PLO2 | PLO3 | PLO4 | PLO5 |
|---|---|---|---|---|---|
| CLO1 | 3 | 2 | 3 | - | - |
| CLO2 | 3 | 3 | 3 | 2 | 2 |
| CLO3 | 3 | 2 | 3 | 3 | 3 |
| CLO4 | 2 | 3 | 3 | 3 | 2 |
| CLO5 | 3 | 3 | 3 | 3 | 3 |
| **3** - Substantial (high) | | **2** - Moderate (medium) | | **1** - Slight (low) | |

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# Elective- I: Blockchain Technology and Applications

| Unit | Content | No. of Hours |
|---|---|---|
| I | **Introduction to Blockchain:** The big picture of the industry – size, growth, structure, players. Bit coin versus Crypto currencies versus Blockchain - Distributed Ledger Technology (DLT). Strategic analysis of the space – Blockchain platforms, regulators, application providers. The major application: currency, identity, chain of custody | 12 |
| II | **Features of Blockchain**: Advantage over conventional distributed database – Blockchain Network, Mining Mechanism, Distributed Consensus, Blockchain 1.0, 2.0 and 3.0 – transition, advancements and features. Privacy, Security issues in Blockchain. | 12 |
| III | **Cryptocurrency** - History, Distributed Ledger, Bitcoin protocols - Symmetric-key cryptography - Public-key cryptography - Digital Signatures -High and Low trust societies - Types of Trust model: Peer-to-Peer, Leviathan, and Intermediary. Application of Cryptography to Blockchain | 12 |
| IV | **Cryptocurrency Regulation** - Stakeholders, Roots bit coin, Legal views - exchange of cryptocurrency – Black Market – Global Economy. **Cyrpto Economics**: assets, supply and demand, inflation & deflation – Regulation | 12 |
| V | **Opportunities and challenges in Blockchain:** Application of Blockchain - Industry 4.0 – machine to machine communication –Data Management Industry 4.0 – future chain in Health 4.0 – Blockchain properties - Healthcare Costs - Healthcare Quality - Healthcare Value - Challenges for using Blockchain for healthcare data | 12 |
| | **Total Hours** | **60** |

**Text Books**

| 1 | Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder, (2016), Bitcoin and Crypto Currency Technologies: A Comprehensive Introduction, Princeton University Press. |
|---|---|
| 2 | Antonopoulos (2014), Mastering Bitcoin: Unlocking Digital Crypto Currencies, O'Reilly Media. |

**Reference Books**

| 1 | Satoshi Nakamoto, (2008), Bitcoin: A Peer-to-Peer Electronic Cash System. |
|---|---|
| 2 | Rodrigoda Rosa Righi, Antonio Marcos Alberti, Madhusudan Singh, (2020), Blockchain Technology for Industry 4.0, Springer. |

**Web Resources (Swayam / NPTEL)**

| 1 | https://onlinecourses.swayam2.ac.in/aic21_ge01/preview |
|---|---|
| 2 | https://onlinecourses.nptel.ac.in/noc24_cs15/announcements?force=true |
| 3 | https://nptel.ac.in/courses/106105184 |

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| Course Code | Course Name | Category | Hours / Week | Credits |
|---|---|---|---|---|
| **25MCS1CE** | **Data Preprocessing and Visualization** | **Elective - I** | **4** | **4** |

## Course Objectives

The course intends to cover
- Different types of databases.
- Data cleaning levels for data preprocessing.
- Data Visualization using Python with 2D and 3D plotting.

## Course Learning Outcomes

On the successful completion of the course, students will be able to

| CLO | CLO Statements | Knowledge Level |
|---|---|---|
| CLO1 | Understand the basic concepts of data and types of databases. | K1, K2 |
| CLO2 | Apply various levels of data cleaning in data preprocessing. | K3 |
| CLO3 | Interpolate data integration and data reduction. | K3 |
| CLO4 | Explore the data transformation and visualization skills using Python. | K4 |
| CLO5 | Infer advanced plotting techniques using matplotlib library in Python. | K3 |
| **K1** - Remember;  **K2** - Understand;  **K3** - Apply;  **K4** – Analyze | | |

## CLO – PLO Mapping

| CLOs/PLOs | PLO1 | PLO2 | PLO3 | PLO4 | PLO5 |
|---|---|---|---|---|---|
| CLO1 | 2 | 2 | 2 | 1 | 1 |
| CLO2 | 2 | 2 | 2 | - | 2 |
| CLO3 | 3 | 3 | 2 | 1 | 2 |
| CLO4 | 3 | 3 | 1 | - | 3 |
| CLO5 | 3 | 3 | 1 | - | 3 |
| **3** - Substantial (high) | | **2** - Moderate (medium) | | **1** - Slight (low) | |

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# Elective – I: Data Preprocessing and Visualization

| Unit | Content | No. of Hours |
|------|---------|--------------|
| I | **Introduction**: Data, Information, Knowledge and Wisdom (DIKW) pyramid – DIKW for data analytics – Data Preprocessing for data analytics versus machine learning – Data Objects – Data Attributes – types of data values – Information versus Pattern - Databases – Types of Databases – Connecting to, and pulling data from databases. | 11 |
| II | **The Preprocessing**: Purpose of data analytics – Tools for data analytics - Levels of data cleaning –Mapping the purposes and tools of analytics to the levels of data cleaning – Cleaning up the table –Unpacking columns and reformulating the table – restructuring the table – Missing values – Outliers – Errors. | 11 |
| III | **Data Fusion and Data Integration**: Data fusion versus Data integration – Directions of data integration – Entity identification – Unwise data collection – Index mismatched formatting – Aggregation mismatch – Duplicate data objects – data redundancy. Data Reduction: Objectives of data reduction – distinction between data reduction and data redundancy – Random sampling – Stratified sampling – Random over/under sampling – Performing dimensionality data reduction. | 14 |
| IV | **Data Transformation and Massaging**: Normalization and standardization – Binary coding, ranking transformation and discretization – Attribute construction – Feature extraction – Log transformation – Smoothing, aggregation and binning. Data Visualization: Data visualization in Python – Matplotlib for data visualization – Matplotlib figure with two subplots – Saving plots to file – Customize plot – Changing line and marker styles – Adding annotations and text – Creating subplots – Adjusting axis limits and tick marks – Using color maps. | 12 |
| V | **Advanced Plotting Techniques 2D:** Bar plot – Histogram – Box plot – Violin plot – Area plot – Stacked area plot –Polar plot – Pie chart – Heatmap – Contour plot – Hexbin plot – Stream plot. Advanced Plotting Techniques 3D: Surface terrain plot – Quiver plot – Tri-surface plot – Wireframe plot – Ribbon plot – Delaunay Triangulation plot – 3D polar plot – 3D Scatter plot – 3D Vector plot – Animated plot. | 12 |
| | **Total Hours** | **60** |

**Text Books**

| 1. | Roy Jafari, (2022), Hands-on Data Preprocessing in Python, Packt Publishing Ltd. |
|----|----|
| 2. | Dr. Abhinav, (2023), Data Visualization using Python Programming, Shashwat Publication. |

| | |
|---|---|
| **Reference Books** | |
| 1. | Reis, Joe, Housley, Matt (2022), Fundamentals of Data Engineering, O'Reilly Media. |
| 2. | Ihab F. Ilyas, Xu Chu (2019), Data Cleaning, Association for Computing Machinery. |
| **Web Resources (Swayam / NPTEL)** | |
| 1. | https://onlinecourses.nptel.ac.in/noc22_cs32/preview |
| 2. | https://onlinecourses.nptel.ac.in/noc21_cs45/preview |

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| Course Code | Course Name | Category | Hours / Week | Credits |
|:---:|:---:|:---:|:---:|:---:|
| **25SOF1AE** | **Soft Skills** | **AECC - I** | **2** | **2** |

# Course Objectives

The course intends to cover:

- The essential soft skills that is crucial for success in today's dynamic and interconnected workplace.

# Course Learning Outcomes

On the successful completion of the course, students will be able to

| CLO | CLO Statements | Knowledge Level |
|:---:|---|:---:|
| CLO1 | Understand the comprehensive skills to participate actively in conversation, writing short texts with expression | K1, K2, K3 |
| CLO2 | Infer the cohesive devices to describe and discuss any objects, pictures using compound, complex sentence forms. | K2, K3 |
| CLO3 | Comprehend the logic in the given situation to organize the ideas to write formal and informal letters. | K2, K3 |
| CLO4 | Understand the given material to organize it in a logical sequence to present a paragraph with main and supporting ideas with concluding sentences. | K3 |
| CLO5 | Present valuable ideas in conversation to emulate the main ideas and key points in short essays. | K3 |
| **K1** - Remember; **K2** - Understand; **K3** – Apply | | |

# Ability Enhancement Compulsory Course - I : Soft Skills

| Module | Unit | Details | No. of Hours |
|---|---|---|---|
| | | **Presentation Skills** | |
| I | 1 | **Getting to Know You:** Grammar: Introduction to Tenses, Everyday English, Role-Play. Reading Activity: Different ways of communication. *Activities*: Fill in the blanks (Listening), Self Introduction (Speaking). | 6 |
| | 2 | **My Day:** Grammar: Present simple positive & negative/Adverbs of Frequency, Vocabulary & Speaking about Daily Activities. Listening: Observe and Answer/ Telling the time. *Activities:* Reading & Writing: Describe where you live. | |
| | 3 | **Your World:** Grammar: Possessive determiners. Listening: Positive & negative contractions. Reading & Writing: Personal profile. *Activities:* Talk about countries, nationalities (Vocabulary & Speaking). | |
| | 4 | **The World of Work:** Grammar: Yes/No & Wh Questions. Vocabulary & Speaking: Jobs. Listening: Recognize the schwa sound. *Activities:* Opening and closing an email (Reading & Writing). | |
| | 5 | **Places and Things:** Grammar: There is / there are, articles. Vocabulary & Speaking: Talk about rooms & furniture. Listening: Directions. Reading & Writing: Imperatives. | |
| | 6 | **24 Hours:** Grammar: Likes & Dislikes. Vocabulary & Speaking: Speak about hobbies and interests. Reading: Match the photos with descriptions. Writing: Write complete sentence using prompt. *Activities:* Observe & answer *(Listening).* | |
| | | **Practice**: Listening & Speaking Presentations - Talking about how you learn – Understanding key information in a presentation – Writing sentences about you. | |
| | | **Confidence** | |
| II | 1 | **Clothes and Shopping:** Grammar: Modal verbs/Adverbs of Frequency/Adjectives and Adverbs. Vocabulary & Speaking: Shopping. Reading & Writing: Product Review. *Activities:* Observe & answer *(Listening).* | 6 |
| | 2 | **Travel & Transport:** Grammar: Past simple questions. Vocabulary & Speaking: Talk about holidays. Listening: At the train station. *Activities:* Email - A perfect holiday (Reading & Writing). | |
| | 3 | **Health & Fitness:** Grammar: Past simple irregular verbs; Listening: Listen & Answer; Reading & Writing: Time sequencers; *Activities:* Talk about a healthy lifestyle (Vocabulary & Speaking) | |
| | 4 | **Music:** Grammar: Present perfect simple; Vocabulary & Speaking: Survey about music; Listening: Listen two people talk about music; *Activities:* Use adjectives and create sentences (Reading) | |
| | 5 | **Let's go shopping:** Vocabulary & Speaking: Town Survey; Listening: Listen and answer; Reading & Writing: Read and match; Activities: Countable & Uncountable **(**Grammar) | |
| | | **Practice**: Writing a personal statement. | |

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| | | Creativity | |
|---|---|---|---|
| III | 1 | **Cooking & Eating:** Grammar: Some & Any, Quantifiers. Vocabulary & Speaking about Food & Drink. *Activities* Kitchen conversation (Listening). Reading an article & answering. | 6 |
| | 2 | **Survival:** Grammar: Comparison of adjectives. *Activities* Describing people (Speaking and Vocabulary). Listening to an audio & Answering. Reading & Writing: Read and Answer. | |
| | 3 | **Working Together:** Grammar: Verb + Noun phrases. *Activities* Technology (Vocabulary & Speaking). Listening: Listen & Answer. Reading & Writing: Notice. | |
| | 4 | **Music:** Grammar: Present perfect simple. *Activities* Survey about music (Vocabulary & Speaking). Listen to two people talking about music (Listening). Reading: Use adjectives and create sentences. | |
| | 5 | **Culture and Arts:** Grammar: Present perfect.Vocabulary & Speaking activity: Speak on the phone. *Activities:* Listen and answer. Reading & Writing activity: Review. | |
| | | **Practice**: Writing comparison sentences & paragraphs. | |
| IV | | **Problem-Solving** | |
| | 1 | **Do's and Don'ts:** Grammar, Modal Verbs. *Activities* Roleplay (Speaking). Holidays in January (Listening). Reading an article & answering. | 6 |
| | 2 | **Body:** Grammar: First conditional. Vocabulary & Speaking about Personality & Appearance. *Activities* Conversations about personality (Listening), Reading & Writing: Read and Answer about your skills. | |
| | 3 | **Speed:** Grammar: Present simple passive. Vocabulary & Speaking about relationships. Listening: Listen & Answer. Reading and Error spotting. | |
| | 4 | **Work:** Grammar: Adverbs of manner. Vocabulary & Speaking about work advice. Listening: Observe & Answer; Reading: Read & check your ideas. | |
| | | **Practice**: Writing argumentative and descriptive essays. | |
| V | | **Critical Thinking** | |
| | 1 | **Influence:** Grammar: would / past habits. Listening: Sentence Correction. *Activities* Your inspiration (Speaking). Picture description (Reading).Rewrite the sentences (Writing). | 6 |
| | 2 | **Money:** Grammar: Second conditional. *Activities:* Radio programme (Listening). Talk about games (Speaking). Reading & Writing: Fill in the blanks. | |
| | 3 | **Things that changed the world:** Grammar: articles. *Activities* :Talk about chewing gum (Speaking & Listening). Reading & Writing: Read and write a book review. | |
| | | **Practice**: Writing Emails, reports and proposals. | |
| | | **Total Hours** | **30** |

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## Components for Internal Assessment and Distribution of Marks for CIA and ESE (Theory)

| Max Marks | Marks for | | Components for CIA | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 100 | CIA | ESE | CIA | | Model | | Attendance | Active Engagement | Total |
| | 25 | 75 | Actual | Weightage | Actual | Weightage | 5 | 5 | 25 |
| | | | 50 | 5 | 75 | 10 | | | |

## Question Paper Pattern

| Component | Duration in Hours | Section A | | | Section B | | | Section C | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Type of Question | No. of Questions | Marks | Type of Question | No. of Questions | Marks | Type of Question | No. of Questions | Marks | |
| CIA | 2 | MCQ | 8 | 8x1=8 | Either or | 3 | 3x6=18 | Either or | 3 | 3x8=24 | 50 |
| Model Exam / ESE | 3 | MCQ | 10 | 10x1=10 | Either or | 5 | 5x5=25 | Either or | 5 | 5x8=40 | 75 |

## Components for Internal Assessment and Distribution of Marks for CIA (Lab)

| Max Marks | Marks for | | Components for CIA | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | CIA | ESE | Test | | Model | | Experiments / Programs | Observation | Total |
| 100 | 40 | 60 | Actual | Weightage | Actual | Weightage | Marks | 5 | 40 |
| | | | 50 | 10 | 60 | 15 | 10 | | |

## Examination Pattern

| Component | Duration in Hours | Marks | | | Total Marks |
|---|---|---|---|---|---|
| | | Practical Exam | Record | Weightage | |
| Test | 2 | 50 | - | 10 | 50 |
| Model | 3 | 60 | - | 15 | 60 |
| Experiments | - | - | - | 10 | 10 |
| Observation | - | - | - | 05 | 05 |
| | | Total Marks - CIA | | 40 | 40 |
| ESE | 3 | 50 | 10 | - | 60 |

# Components for and Distribution of Marks for ESE (Theory)
## Ability Enhancement Compulsory Courses (AECC)
## &
## Question Paper Pattern

| Duration in Hours | Mode of Exam | Type of Questions | No. of Questions | Marks |
|---|---|---|---|---|
| 2 | Online | MCQ | 50 | 50x1=50 |

# Semester 2

| Course Code | Part | Course Category | Course Name | Hours / Week | Duration in Hours | CIA | ESE | Total | Credits |
|---|---|---|---|---|---|---|---|---|---|
| Semester – 2 | | | | | | | | | |
| | | | | | | **Examination** | | | |
| | | | | | | **Max Marks** | | | |
| 25MCS21C | III | Core - V | Advanced Java Programming | 5 | 3 | 25 | 75 | 100 | 4 |
| 25MCS22P | III | Core Lab- III | Advanced Java Programming Lab | 4 | 3 | 40 | 60 | 100 | 3 |
| 25MCS23C | III | Core - VI | Artificial Intelligence and Machine Learning | 5 | 3 | 25 | 75 | 100 | 4 |
| 25MCS24P | III | Core Lab- IV | Artificial Intelligence and Machine Learning Lab | 4 | 3 | 40 | 60 | 100 | 3 |
| 25MCS25C | III | Core - VII | Data Mining | 4 | 3 | 25 | 75 | 100 | 4 |
| 25MCS2AE | III | Elective - II | Big Data Analytics | 4 | 3 | 25 | 75 | 100 | 4 |
| 25MCS2BE | III | | Ethical Hacking | | | | | | |
| 25MCS2CE | III | | Neural Networks and Deep Learning | | | | | | |
| 25MCS26P | III | SEC Lab - I | Data Mining Lab | 2 | 3 | 40 | 60 | 100 | 3 |
| 25QUA2AE | IV | AECC - II | Quantitative Aptitude | 2 | 2 | - | 50 | 50 | 2 |
| **Total** | | | | **30** | | | | **750** | **27** |

| Course Code | Course Name | Category | Hours / Week | Credits |
|---|---|---|---|---|
| 25MCS21C | **Advanced Java Programming** | **Core - V** | **5** | **4** |

## Course Objectives

The course intends to

- Understand advanced concepts of Java programming.
- Learn JDBC, servlet packages, Java Server Pages and JAR file formats.
- Enhance GUI based program using swing concepts.

## Course Learning Outcomes

On the successful completion of the course, students will be able to

| CLO | CLO Statements | Knowledge Level |
|---|---|---|
| CLO1 | Remember the basic and networking concepts of Java Programming. | K1 |
| CLO2 | Understand the remote method invocation. | K2 |
| CLO3 | Apply Java with databases and Hibernate. | K3 |
| CLO4 | Analyze Servlet and evaluate JSP for client and server web application. | K4, K5 |
| CLO5 | Create interactive applications using advanced techniques. | K6 |
| **K1** - Remember;**K2** - Understand;  **K3** - Apply;  **K4** – Analyze;  **K5 –** Evaluate;  **K6 -** Create | | |

## CLO – PLO Mapping

| CLOs/PLOs | PLO1 | PLO2 | PLO3 | PLO4 | PLO5 |
|---|---|---|---|---|---|
| CLO1 | 2 | 1 | 3 | 2 | 2 |
| CLO2 | 3 | 2 | 1 | 3 | 3 |
| CLO3 | 1 | 3 | 2 | 2 | 3 |
| CLO4 | 2 | 3 | 3 | 1 | 2 |
| CLO5 | 3 | 2 | 3 | 3 | 3 |
| **3** - Substantial (high) | | **2** - Moderate (medium) | | **1** - Slight (low) | |

# Core V - Advanced Java Programming

| Unit | Content | No. of Hours |
|---|---|---|
| I | **Introduction:** Java Basics Review: Components and event handling – Threading concepts. **Java Networking**: Network Basics and Socket overview - TCP/IP client sockets - TCP/IP server sockets – Datagrams - java.net package Socket-Server Socket- Inet Address- URL- URL Connection | 12 |
| II | **Remote Method Invocation**: Distributed Application Architecture- Creating stubs and skeletons - Defining Remote objects - Remote Object Activation - Object Serialization - Java Spaces. | 15 |
| III | **Database**: Java in Databases- JDBC principles - Database access – Interacting - database search - Creating multimedia databases - Database support in web applications. **Hibernate 4.0**: Overview of Hibernate - Hibernate Architecture - Hibernate Mapping Types - Hibernate O/R Mapping - Hibernate Annotation - Hibernate Query Language. | 16 |
| IV | **Java Servlets**: Java Servlet and CGI programming - A simple Java Servlet program - Anatomy of a Java Servlet - Reading data from a client - Reading http request header - sending data to a client and writing the http response header - working with cookies. **Java Server Pages**: JSP Overview – Installation - JSP tags - Components of JSP page - Expressions –Scriptlets – Directives - Declarations -A complete example. | 16 |
| V | **Advanced Techniques**: JAR file format creation - Internationalization - Swing Programming - Advanced Java techniques. **Java Server Faces 2.0**: Introduction to JSF - JSF request processing Life cycle - JSF Components - Integrating JSF with JDBC. | 16 |
| | **Total Hours** | **75** |

**Text Books**

1. Cay S.Horstmann (2024), Core Java Advanced Features, Pearson education.
2. Uttam K Roy (2015), Advanced Java Programming, 1st Edition, Oxford University Press, India.
3. Jamie Jaworski (1999), Java Unleashed, SAMST Tech Media Publications.

**Reference Books**

1. David Swayer McFarland (2011), Java Script and JQuery – The Missing Manual, 3rd Edition, Oreilly Publication.
2. JimKeogh (2010), The Complete Reference J2EE, Tata McGraw Hill Publishing Company Ltd.
3. Campione, Walrath and Huml (1999), The Java Tutorial, Addison Wesley.

**Web Resources (Swayam / NPTEL)**

1. https://onlinecourses.nptel.ac.in/noc22_cs47/preview
2. https://onlinecourses.swayam2.ac.in/nou24_cs09/preview

| Course Code | Course Name | Category | Hours / Week | Credits |
|---|---|---|---|---|
| 25MCS22P | Advanced Java Programming Lab | Core Lab - III | 4 | 3 |

| S. No. | List of Programs |
|---|---|
| Basic Java programs using OOPs concept. | |
| 1. | Display a welcome message using Servlet. |
| 2. | Write a program to build a simple Client Server application using RMI. |
| 3. | Write a program using JDBC for creating a table, Inserting, deleting records and list out the records. |
| 4. | Prepare an Employee pay slip using JSP. |
| 5. | Creating a Database Application using Hibernate. |
| 6. | Program using Java Servlet to handle form data. |
| 7. | Develop a simple Servlet program to create a table of all the headers it receives along with their associated values. |
| 8. | Program in JSP by using session object. |
| 9. | Design a Purchase Order form using Html form and JSP. |
| 10. | Create a web application that utilizes UI components using Java Server Faces. |
| 11. | Create UI widgets and other components including windows, menus and buttons using AWT and Swing. |
| 12. | Program to send a text message to another system and receive the text message from the system (use socket programming). |
| | **Total Hours** 60 |

**Text Books**

| | |
|---|---|
| 1. | Cay S.Horstmann (2024), Core Java Advanced Features, Pearson education. |
| 2. | Uttam K Roy (2015), Advanced Java Programming, 1st Edition, Oxford University Press, India. |
| 3. | Jamie Jaworski (1999), Java Unleashed, SAMST Tech Media Publications. |

**Reference Books**

| | |
|---|---|
| 1. | David Swayer McFarland (2011), Java Script and JQuery – The Missing Manual, 3rd Edition, Oreilly Publication. |
| 2. | JimKeogh (2010), The Complete Reference J2EE, Tata McGraw Hill Publishing Company Ltd. |
| 3. | Campione, Walrath and Huml (1999), The Java Tutorial, Addison Wesley. |

**Web Resources (Swayam / NPTEL)**

| | |
|---|---|
| 1. | https://onlinecourses.nptel.ac.in/noc22_cs47/preview |
| 2. | https://onlinecourses.swayam2.ac.in/nou24_cs09/preview |
| 3. | https://onlinecourses.nptel.ac.in/noc19_cs84/preview |
| 4. | https://onlinecourses.nptel.ac.in/noc21_cs03/preview |

**Department of Computer Science[PG]**

| Course Code | Course Name | Category | Hours / Week | Credits |
|---|---|---|---|---|
| **25MCS23C** | **Artificial Intelligence and Machine Learning** | **Core - VI** | **5** | **4** |

## Course Objectives

The course intends to

- Learn functions of AI and general search techniques.
- Understand the concepts of representations, mappings and predicate logic.
- Learn machine learning with Data Mining, Big Data and Cloud.
- Enhance the applications, impact of machine learning and generative AI.

## Course Learning Outcomes

On the successful completion of the course, students will be able to

| CLO | CLO Statements | Knowledge Level |
|---|---|---|
| CLO1 | Demonstrate AI problems and design the techniques. | K1, K2 |
| CLO2 | Understand knowledge designing techniques and use algorithms for ML training. | K2, K3 |
| CLO3 | Apply basic principles of AI in solutions that require problem solving, inference, perception, knowledge representation, and learning. | K3, K4 |
| CLO4 | Explore the impact of machine learning on applications for real time implementation. | K4 |
| CLO5 | Analyze real-world problems for implementation and understand the dynamic behavior of a system. | K4 |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze | | |

## CLO – PLO Mapping

| CLOs/PLOs | PLO1 | PLO2 | PLO3 | PLO4 | PLO5 |
|---|---|---|---|---|---|
| CLO1 | 1 | 2 | 3 | 3 | 3 |
| CLO2 | 1 | 2 | 3 | 3 | 3 |
| CLO3 | 3 | 2 | 3 | 3 | 3 |
| CLO4 | 3 | 2 | 3 | 3 | 3 |
| CLO5 | 3 | 2 | 3 | 3 | 3 |
| **3** - Substantial (high) | | **2** - Moderate (medium) | | **1** - Slight (low) | |

**Department of Computer Science[PG]**

# Core – VI: Artificial Intelligence and Machine Learning

| Unit | Content | No. of Hours |
|---|---|---|
| I | **Introduction:** AI Problems - Al techniques - Criteria for success. Problems, Problem Spaces, Search: State space search - Production Systems - Problem Characteristics - Issues in design of Search. | 14 |
| II | **Heuristic Search techniques:** Generate and Test - Hill Climbing - Best-First, Problem Reduction, Constraint Satisfaction, Means-end analysis. Knowledge representation issues: Representations and mappings -Approaches to Knowledge representations - Issues in Knowledge representations – Frame Problem. | 15 |
| III | **Using Predicate logic**: Representing simple facts in logic - Representing Instance and Isa relationships - Computable functions and predicates - Resolution - Natural deduction. Representing knowledge using rules: Procedural Vs Declarative knowledge- Logic programming – Forward Vs Backward reasoning – Matching - Control knowledge. | 16 |
| IV | **Understanding Machine Learning:** Introduction to Machine Learning - defining Big Data - Big Data in Context with Machine Learning - The Importance of the Hybrid Cloud - Leveraging the Power of Machine Learning - The Roles of Statistics and Data Mining with Machine Learning - Putting Machine Learning in Context - Approaches to Machine Learning. | 16 |
| V | **Looking Inside Machine Learning:** The Impact of Machine Learning on Applications – Data Preparation - The Machine Learning Cycle. **Introduction to Generative AI:** Types of Generative AI Models. | 14 |
| | **Total Hours** | **75** |

**Text Books**

| 1. | Elaine Rich and Kevin Knight (2017), Artificial Intelligence, Tata McGraw Hill Publishers company Pvt Ltd, 2$^{nd}$ Edition. |
|---|---|
| 2. | Stuart J. Russell and Peter Norvig (2010), Artificial Intelligence A Modern Approach, 3$^{rd}$ Edition, Pearson Education. |
| 3. | Denis Rothmanl (2022), Artificial Intelligence, By Example 2$^{nd}$ Edition, Packt. |
| 4. | Vinod Chandra, (2022) Artificial Intelligence and Machine Learning, 1$^{st}$ Edition, kindle. |

**Reference Books**

| 1. | George F Luger (2002), Artificial Intelligence, 4$^{th}$ Edition Pearson Education Publication. |
|---|---|
| 2. | Judith Hurwitz, Daniel Kirsch (2010), Machine Learning for Dummies, IBM Limited Edition. |

**Web Resources (Swayam / NPTEL)**

| 1. | https://nptel.ac.in/courses/106106226 |
|---|---|
| 2. | https://nptel.ac.in/courses/106106140 |
| 3. | https://nptel.ac.in/courses/106106158 |
| 4. | https://nptel.ac.in/courses/106101360 |

**Department of Computer Science[PG]**

| Course Code | Course Name | Category | Hours / Week | Credits |
|---|---|---|---|---|
| **25MCS24P** | **Artificial Intelligence and Machine Learning Lab** | **Core Lab - IV** | **4** | **3** |

| S. No. | List of Programs |
|---|---|
| Basics of PROLOG Programming language and its Functions. | |
| 1. | Write simple facts for the statements using PROLOG. |
| 2. | Implementation of Depth First Search for Water Jug problem. |
| 3. | Implementation of Breadth First Search for Tic-Tac-Toe problem. |
| 4. | Solve an 8-puzzle problem using Best First Search. |
| 5. | Write a PROLOG program to solve the N-Queens problem. |
| 6. | Implementation of Traveling Salesman Problem |
| 7. | Implementation of Python Basic Libraries such as Math, NumPy and SciPy |
| 8. | Implementation of Python Libraries for ML applications such as Pandas and Matplotlib. |

| | Total Hours | 60 |
|---|---|---|

**Text Books**

| 1. | George F Luger (2022), Artificial Intelligence, 4$^{th}$ Edition Pearson Education Publication. |
|---|---|
| 2. | Vinod Chandra (2022), Artificial Intelligence and Machine Learning, 1$^{st}$ Edition, kindle. |

**Reference Books**

| 1. | Denis Rothmanl (2022), Artificial Intelligence by Example 2nd Edition, Packt. |
|---|---|
| 2. | Judith Hurwitz, Daniel Kirsch (2010), Machine Learning for Dummies, IBM Limited Edition. |

**Web Resources (Swayam / NPTEL)**

| 1. | https://nptel.ac.in/courses/106106226 |
|---|---|
| 2. | https://nptel.ac.in/courses/106106140 |
| 3. | https://nptel.ac.in/courses/106106158 |
| 4. | https://nptel.ac.in/courses/106101360 |

| Course Code | Course Name | Category | Hours / Week | Credits |
|---|---|---|---|---|
| 25MCS25C | Data Mining | Core - VII | 4 | 4 |

## Course Objectives

The course intends to

- Understand various data mining algorithms to solve real-world problems.
- Learn classification, prediction, clustering and association rule mining of data mining process.
- Enhance data visualization techniques and data mining algorithms to solve real world problem.

## Course Learning Outcomes

On the successful completion of the course, students will be able to

| CLO | CLO Statements | Knowledge Level |
|---|---|---|
| CLO1 | Learn and understand the basic data mining techniques and algorithms | K1, K2 |
| CLO2 | Understand the Association rules and apply Clustering techniques. | K2, K3 |
| CLO3 | Analyze and evaluate different data mining techniques like classification, prediction, Clustering and association rule mining. | K4, K5 |
| CLO4 | Explore statistical methods and visualization techniques. | K4 |
| CLO5 | Apply appropriate data mining algorithms to solve real world problems. | K3 |
| **K1** – Remember; **K2** – Understand; **K3** – Apply; **K4** – Analyze; **K5**-Evaluate | | |

## CLO – PLO Mapping

| CLOs/PLOs | PLO1 | PLO2 | PLO3 | PLO4 | PLO5 |
|---|---|---|---|---|---|
| CLO1 | 3 | 2 | 2 | - | 2 |
| CLO2 | 3 | 2 | 2 | - | 2 |
| CLO3 | 3 | 3 | 3 | 2 | 2 |
| CLO4 | 3 | 3 | 3 | 3 | 3 |
| CLO5 | 3 | 3 | 3 | 3 | 3 |
| **3** - Substantial (high) | | **2** - Moderate (medium) | | **1** - Slight (low) | |

## Core – VII : Data Mining

| Unit | Content | No. of Hours |
|------|---------|--------------|
| I | **Basic data mining tasks** – data mining versus knowledge discovery in databases – data mining issues – data mining metrics – social implications of data mining – data mining from a database perspective. **Data mining techniques**: Introduction – a statistical perspective on data mining – similarity measures – decision trees – neural networks – genetic algorithms. | 12 |
| II | **Classification:** Introduction – Statistical–based algorithms - distance–based algorithms - decision tree-based algorithms - neural network–based algorithms – rule–based algorithms – combining techniques. | 12 |
| III | **Clustering:** Introduction–Similarity and Distance Measures – Outliers – Hierarchical Algorithms – Partitional Algorithms. **Association rules**: Introduction - large item sets - basic algorithms – parallel and distributed algorithms – comparing approaches - incremental rules – advanced association rules techniques – measuring the quality of rules. | 12 |
| IV | **Statistical Descriptions and Data Visualization:** Basic Statistical Descriptions of Data. **Measuring the Central Tendency**: Mean, Median, and Mode. **Measuring the Dispersion of Data**: Range, Quartiles, Variance, Standard Deviation, and Interquartile Range - Graphic Displays of Basic Statistical Descriptions of Data. **Data visualization**: Pixel-Oriented Visualization Techniques - Geometric Projection Visualization Techniques - Icon-Based Visualization Techniques - Hierarchical Visualization Techniques - Visualizing Complex Data and Relations. | 14 |
| V | **Data Mining Trends and Research Frontiers:** Mining Complex Data Types, Other Methodologies of Data Mining, Data Mining Applications, Data Mining and Society, Data Mining trends – Mining the Biological Data – Web Mining. | 10 |
| | **Total Hours** | **60** |

| Text Books | |
|---|---|
| 1. | Margaret H Dunham (2020), Data Mining Introductory and Advanced topics, 1st Edition, Pearson Publication. |
| 2. | Jiawei Han & Micheline Kamber (2012), Data Mining Concepts & Techniques, 3rd Edition, Academic press. |

| Reference Books | |
|---|---|
| 1. | Arun K Pujari (2016), Data Mining Techniques, 4th Edition, Universities Press. |
| 2. | Alex Berson, Stephen J. Smith (2001), Data Warehousing, Data Mining and OLAP, TMCH. |

| Web Resources (Swayam / NPTEL) | |
|---|---|
| 1. | https://onlinecourses.nptel.ac.in/noc24_cs22/preview |
| 2. | https://onlinecourses.swayam2.ac.in/cec19_cs01/preview |

**Department of Computer Science[PG]**

| Course Code | Course Name | Category | Hours / Week | Credits |
|---|---|---|---|---|
| **25MCS2AE** | **Big Data Analytics** | **Elective - II** | **4** | **4** |

## Course Objectives

The course intends to

- Learn R programming, Mapreduce, Hadoop based analytics and HDFS architecture.
- Understand the concepts of big data collection, big data security, Mapreduce architecture and machine learning.

## Course Learning Outcomes

On the successful completion of the course, students will be able to

| CLO | CLO Statements | Knowledge Level |
|---|---|---|
| CLO1 | Interpret the basic and importance of big data. | K1, K2 |
| CLO2 | Understand the R language and its application with big data. | K2 |
| CLO3 | Apply the Hadoop features, HDFS, Data storage methods and technologies. | K3 |
| CLO4 | Infer the security controls in big data. | K3 |
| CLO5 | Analyze HDFS, MapReduce architecture and Machine learning concepts. | K4 |
| **K1** - Remember;     **K2** - Understand;     **K3** - Apply;     **K4** - Analyze | | |

## CLO – PLO Mapping

| CLOs/PLOs | PLO1 | PLO2 | PLO3 | PLO4 | PLO5 |
|---|---|---|---|---|---|
| CLO1 | 3 | 2 | - | 3 | 3 |
| CLO2 | 3 | 2 | 3 | 3 | 2 |
| CLO3 | 2 | 3 | 2 | - | 3 |
| CLO4 | 2 | 2 | - | 3 | 2 |
| CLO5 | 3 | - | - | 2 | 3 |
| **3** - Substantial (high) | | **2** - Moderate (medium) | | **1** - Slight (low) | |

## Elective - II : Big Data Analytics

| Unit | Content | No. of Hours |
|------|---------|--------------|
| I | **Importance of Big Data:** Introduction to big data analytics - what is big data? - Challenges in big data - Big data in business perspectives - Big data from technology perspectives - 5 V's of big data. **Importance of Big Data**: A Flood of Mythic. **Industry Examples of Data**: Digital Marketing and the Non - line World – Database Marketers, Pioneers of Big Data – Big Data and the New School of Marketing. | 12 |
| II | **Data analytics tools for Big Data:** An overview of analytics tools - R and Hadoop - Installing R - Installing R Studio - Understanding the features of R language - Using R - packages - Performing data operations - Increasing community support - Performing data modeling in R.- Hadoop environment - Core component of Hadoop - Mapreduce working methodology. **Case study**: Walmart data processing. Introduction to Apache Spark. | 10 |
| III | **HDFS and Storage of data**: Understanding Hadoop features - Understanding HDFS - Understanding the characteristics of HDFS - Understanding MapReduce - Learning the HDFS and MapReduce architecture. Big Data Storage - Big Data Storage Challenges - Key Insights for Big Data Storage. **Data storage methods**: Warehouse Storage - Cloud Storage. **Data Storage Technologies**: Hadoop - HBase. Case Study: Health care data storage and challenges. | 14 |
| IV | **Security Planning in Big data:** Big data security - Important to secure big data - The architecture of big data security - Big data security works - Types of data security controls - The major big data security challenges - The big data security best practices. The best security tools for big data storage. | 12 |
| V | **MapReduce Architecture & ML:** Understanding the HDFS architecture - Understanding HDFS components - Understanding the MapReduce architecture - Understanding MapReduce components. **Machine Learning**: Introduction, Supervised Learning, Unsupervised Learning, Big Data Analytics with R. | 12 |
| | **Total Hours** | **60** |

**Text Books**

| | |
|---|---|
| 1. | EMC Education Services (2015), Data Science in Big Data Analytics: Discovering, Analyzing, Visualization and Presenting Data , 1st Edition, John Wiley and Sons. |
| 2. | Michael Minelli, Michele Chambers, Ambiga Dhiraj (2014), Big Data Big Analytics, Wiley Publications, Indian Reprint. |

**Reference Books**

| | |
|---|---|
| 1. | Vignesh Prajapati (2013), Big Data Analytics with R and Hadoop, PACKT Publishing. |
| 2. | Chris Eaton, Dirk Deroos,Tom Deutsch, George Lapis, Paul Zikopoulos (2012), Understanding Big Data, Analytics for Enterprise Class Hadoop and Streaming Data, Tata Mc Graw Hill. |

**Web Resources (Swayam / NPTEL)**

| | |
|---|---|
| 1. | https://onlinecourses.nptel.ac.in/noc20_cs92/preview |

**Department of Computer Science[PG]**

| Course Code | Course Name | Category | Hours / Week | Credits |
|:---:|:---:|:---:|:---:|:---:|
| **25MCS2BE** | **Ethical Hacking** | **Elective - II** | **4** | **4** |

## Course Objectives

The course intends to

- Understand the fundamentals of hacking, foot printing and scanning.
- Detect the threats caused by malware, denial of service, sniffers and session hijacking.
- Enhance the problems and solutions for web server and database server hacking.
- Learn the attacks of mobile security, wireless technologies, IDS and firewalls.

## Course Learning Outcomes

On the successful completion of the course, students will be able to

| CLO | CLO Statements | Knowledge Level |
|:---:|:---|:---:|
| CLO1 | Learn and understand the foundations of ethical hacking. | K1, K2 |
| CLO2 | Defend the concepts of foot printing, windows enumeration and system hacking. | K2 |
| CLO3 | Explore the various forms of malware threats. | K4 |
| CLO4 | Analyze the web server and web application hacking. | K4 |
| CLO5 | Apply the concept of firewalls, honeypots and physical security. | K3 |
| **K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze | | |

## CLO – PLO Mapping

| CLOs/PLOs | PLO1 | PLO2 | PLO3 | PLO4 | PLO5 |
|:---:|:---:|:---:|:---:|:---:|:---:|
| CLO1 | 2 | 1 | 3 | 2 | 2 |
| CLO2 | 3 | 2 | 1 | 3 | 3 |
| CLO3 | 1 | 3 | 2 | 2 | 3 |
| CLO4 | 2 | 3 | 3 | 1 | 2 |
| CLO5 | 3 | 2 | 3 | 3 | 3 |
| **3** - Substantial (high) | | **2** - Moderate (medium) | | **1** - Slight (low) | |

## Elective- II: Ethical Hacking

| Unit | Content | No. of Hours |
|------|---------|--------------|
| I | **An Introduction to ethical Hacking:** Security Fundamental - Security testing - Hacker and Cracker – Descriptions - Test Plans - keeping it legal - Ethical and Legality. **The Technical Foundations of Hacking**: The Attacker's Process -The Ethical Hacker's Process - Security and the Stack. | 10 |
| II | **Foot printing and scanning:** Information Gathering, Determining the Network Range, Identifying Active Machines, Finding Open Ports and Access Points, OS Fingerprinting Services, Mapping the Network Attack Surface. **Enumeration and System Hacking**: Windows Enumeration - NetBIOS and LDAP Enumeration - SNMP Enumeration - Nontechnical Password Attacks - Technical Password Attacks - Privilege Escalation and Exploiting Vulnerabilities. | 14 |
| III | **Malware Threats**: Viruses and Worms - Trojans - Covert Communication - Keystroke Logging and Spyware - Malware Counter measures – Sniffers. **Session Hijacking and Denial of Service**: Sniffers - Session Hijacking - Denial of Service and Distributed Denial of Service. | 11 |
| IV | **Web Server - Applications and Database Attacks**: Web Server Hacking - Web Application Hacking - Database Hacking - Wireless Technologies. **Mobile Security and Attacks**: Wireless Technologies - Mobile Device Operation and Security - Wireless LANs - Wireless Hacking Tools - Securing Wireless Networks. | 13 |
| V | **IDS - Firewalls and Honeypots**: Intrusion Detection Systems - Firewalls – Honeypots. **Physical Security and Social Engineering**: Physical Security - Social Engineering. | 12 |
| | **Total Hours** | **60** |

**Text Books**

| | |
|---|---|
| 1. | Michael Gregg (2017), Certified Ethical Hacker, Version 9, 2nd Edition, Pearson IT Certification. |
| 2. | Ankit Fadia (2006), The Unofficial Guide to Ethical Hacking, 2nd Edition, Premier Press. |

**Reference Books**

| | |
|---|---|
| 1. | Gray hat hacking (2011), The Ethical hackers handbook – Allen Harper,Shon Harris, Jonathan Ness, 3rd Edition, Mc GrawHill. |
| 2. | Alana Maurushat (2019), Ethical Hacking, University of Ottawa Press, Les Presses de Publisher. |

**Web Resources (Swayam / NPTEL)**

| | |
|---|---|
| 1. | https://onlinecourses.nptel.ac.in/noc23_cs44/preview |
| 2. | https://onlinecourses.nptel.ac.in/noc22_cs13/preview |

**Department of Computer Science[PG]**

| Course Code | Course Name | Category | Hours / Week | Credits |
|---|---|---|---|---|
| **25MCS2CE** | **Neural Networks and Deep Learning** | **Elective - II** | **4** | **4** |

## Course Objectives

The course intends to

- Understand the concepts of Neural networks in engineering, artificial intelligence and cognitive modelling.
- Learn the basics of supervised learning in neural networks.
- Enhance the role of machine learning and deep neural networks.

## Course Learning Outcomes

On the successful completion of the course, students will be able to

| CLO | CLO Statements | Knowledge Level |
|---|---|---|
| CLO1 | Recite the basics of neural networks. | K1 |
| CLO2 | Understand the various techniques of single layer perceptron. | K2 |
| CLO3 | Apply the back propagation techniques. | K3 |
| CLO4 | Interpolate the basics of machine learning. | K2 |
| CLO5 | Infer the newer optimization methods for deep neural networks. | K3 |
| **K1** - Remember;      **K2** - Understand;      K**3** - Apply | | |

## CLO – PLO Mapping

| CLOs/PLOs | PLO1 | PLO2 | PLO3 | PLO4 | PLO5 |
|---|---|---|---|---|---|
| CLO1 | 1 | 1 | 1 | 2 | 2 |
| CLO2 | 2 | 2 | 2 | 2 | 2 |
| CLO3 | 2 | 3 | 2 | 2 | 2 |
| CLO4 | 1 | 2 | 2 | 2 | 2 |
| CLO5 | 2 | 3 | 2 | 2 | 2 |
| **3** - Substantial (high) | | **2** - Moderate (medium) | | **1** - Slight (low) | |

## Elective II：Neural Networks and Deep Learning

| Unit | Content | No. of Hours |
|------|---------|--------------|
| I | **Introduction**: Overview of neural network - Human Brain - Models of a Neuron - Neural networks viewed as Directed Graphs - Network Architectures - Knowledge Representation, Artificial Intelligence and Neural Networks. | 11 |
| II | **Single Layer Perceptron**: Adaptive filtering problem - Unconstrained Organization Techniques - Linear least square filters - least mean square algorithm - learning curves - Learning rate annealing techniques- perception – convergence theorem - Relation between perception and Bayes classifier for a Gaussian Environment. | 13 |
| III | **Back Propagation**: Back propagation and differentiation - Hessian matrix - Generalization - Cross validation - Network pruning Techniques - Virtues and limitations of back propagation learning - Accelerated convergence - supervised learning. | 12 |
| IV | **Introduction to Machine Learning:** Scalars – Vectors – Matrices – Tensors – Identity and Inverse Matrices – Linear Dependence and Span – Eigen Decomposition – Probability – Random Variables – Conditional Probability – Expectation –Variance – Covariance –Bayes' Rule – Supervised Learning Algorithm – Unsupervised Learning Algorithm. | 13 |
| V | **Deep Neural Networks**: Difficulty of training deep neural networks- Greedy layer wise training. **Better Training of Neural Networks**: Newer optimization methods for neural networks - second order methods for training - Saddle point problem in neural networks. | 11 |
| | **Total Hours** | **60** |

**Text Books**

| | |
|---|---|
| 1. | Ian Goodfellow, Yoshua Bengio and Aaron Courville (2017), Deep Learning, MIT Press. |
| 2. | Charu C. Aggarwal (2018), Neural Networks and Deep Learning, $2^{nd}$ Edition, Springer. |

**Reference Books**

| | |
|---|---|
| 1. | Umberto Michelucci (2018), Applied Deep Learning. A Case-based Approach to Understanding Deep Neural Networks. |
| 2. | Kevin P. Murphy (2012), Machine Learning: A Probabilistic Perspective, The MIT Press. |
| 3. | Aaron Courville, Ian Goodfellow, Yoshua Bengio (2016), Deep Learning (Adaptive Computation and Machine Learning series). |
| 4 | Simson Haykin (2016), Neural Networks and Learning Machines, $3^{rd}$ Edition, McMaster University, Pearson Prentice Hall Publications. |

| **Web Resources (Swayam / NPTEL)** |
|---|
| 1.   https://onlinecourses.nptel.ac.in/noc20_cs88/preview |
| 2.   https://onlinecourses.nptel.ac.in/noc24_ge17/preview |
| 3.   https://onlinecourses.nptel.ac.in/noc24_ee01/preview |

**Department of Computer Science[PG]**

| Course Code | Course Name | Category | Hours / Week | Credits |
|:---:|:---:|:---:|:---:|:---:|
| **25MCS26P** | **Data Mining Lab** | **SEC Lab - I** | **2** | **3** |

| S. No. | List of Programs |
|:---:|:---|
| | Basic of R Programming and its functions. |
| 1. | Perform data cleaning techniques for a data set. |
| 2. | Perform Data Normalization using min-max, z-score and normalization by decimal scaling methods. |
| 3. | Find the outliers using various Outlier detection methods. |
| 4. | Implement k-means clustering technique. |
| 5. | Implement any one Hierarchical Clustering. |
| 6. | Implement Classification algorithm. |
| 7. | Implement Decision Tree. |
| 8. | Build a Linear Regression model for electricity consumption prediction. |
| 9. | Implement Apriori algorithm to extract association rule of data mining. |
| 10. | Analyze heart disease risk using data visualization technique. |
| | **Total Hours**     **30** |

**Text Books**

| | |
|:---:|:---|
| 1. | Margaret H Dunham (2020), Data Mining Introductory and Advanced topics, 1st Edition, Pearson Publication. |
| 2. | Jiawei Han & Micheline Kamber, (2012), Data Mining Concepts & Techniques, 3rd Edition, Academic press. |

**Reference Books**

| | |
|:---:|:---|
| 1. | Arun K Pujari (2003) Data Mining Techniques, 3rd Edition, Universities Press. |
| 2. | Alex Berson, Stephen J. Smith (2001), Data Warehousing, Data Mining and OLAP, MCH. |

**Web Resources (Swayam / NPTEL)**

| | |
|:---:|:---|
| 1. | https://onlinecourses.nptel.ac.in/noc24_cs22/preview |
| 2. | https://onlinecourses.swayam2.ac.in/cec19_cs01/preview |

| Course code | Course Name | Category | Hours | Credits |
|---|---|---|---|---|
| 25QUA2AE | **Quantitative Aptitude** | **AECC-II** | **2** | **2** |

## Course Objectives

The Course intends to cover

- To understand the basic concepts of average
- To understand and apply the concepts of HCF and LCM
- To study and understand the basic concepts of percentage
- To learn the concept of profit loss, discounts
- To study and understand about the concepts of simple and compound interest

## Course Learning Outcomes

On the successful completion of the course, students will be able to

| CLO | CLO Statements | Knowledge Level |
|---|---|---|
| CLO1 | Understand and apply the concepts of average and evaluate the problems. | K2,K3,K5 |
| CLO2 | To have basic knowledge and understanding about HCF and LCM | K1,K2,K3 |
| CLO3 | To understand the concepts of Percentage and its calculations | K2,K3,K4,K5 |
| CLO4 | To understand about the concepts of Profit or Loss and discount | K2,K3,K5 |
| CLO5 | To understand the concepts of Simple and Compound Interest and its calculations | K2,K3,K4,K5 |
| **K1** - Remember;  **K2** - Understand;  **K3** - Apply;  **K4** - Analyze;  **K5** - Evaluate | | |

# AECC - II : Quantitative Aptitude

| Unit | Details | No. of Hours |
|---|---|---|
| I | Average - Basic concepts - Equation - Mistaken value - Replacement - Including / Excluding | 6 |
| II | HCF and LCM - Basic Problems - fraction - decimal - Same Remainder-Different Remainder - largest and smallest 3 or 4 digits - Ratio based - Application problems | 6 |
| III | Percentage - Increase/decrease - net change - salary - election - marks - consumption - population/machine | 6 |
| IV | Profit and loss - Profit and loss% - finding cp and sp - profit=loss - same product cp and sp with percentage – Discount | 6 |
| V | Simple interest - finding principal - rate of interest - amount - time period - doubles or triples - Compound interest - finding rate - finding time - principal - doubles or triples - difference between simple and compound interest | 6 |
| | **Total Hours** | **30** |

| **Text Books** | |
|---|---|
| 1. | R.S.Aggarwal.,Quantitative Aptitude, S.Chand & Company Ltd.,. |

| **Reference Books** | |
|---|---|
| 1. | Aashish Arora, Quantitative Aptitude |

| **Web Resources** | |
|---|---|
| 1. | https://www.javatpoint.com/aptitude/quantitative |
| 2. | https://www.indiabix.com/aptitude/questions-and-answers/ |

## Components for Internal Assessment and Distribution of Marks for CIA and ESE (Theory)

| Max Marks | Marks for | | Components for CIA | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | CIA | ESE | CIA | | Model | | Attendance | Active Engagement | Total |
| 100 | 25 | 75 | Actual | Weightage | Actual | Weightage | 5 | 5 | 25 |
| | | | 50 | 5 | 75 | 10 | | | |

## Question Paper Pattern

| Component | Duration in Hours | Section A | | | Section B | | | Section C | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Type of Question | No. of Questions | Marks | Type of Question | No. of Questions | Marks | Type of Question | No. of Questions | Marks | |
| CIA | 2 | MCQ | 8 | 8x1=8 | Either or | 3 | 3x6=18 | Either or | 3 | 3x8=24 | 50 |
| Model Exam / **ESE** | 3 | MCQ | 10 | 10x1=10 | Either or | 5 | 5x5=25 | Either or | 5 | 5x8=40 | 75 |

## Components for Internal Assessment and Distribution of Marks for CIA (Lab)

| Max Marks | Marks for | | Components for CIA | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | CIA | ESE | Test | | Model | | Experiments / Programs | Observation | Total |
| 100 | 40 | 60 | Actual | Weightage | Actual | Weightage | Marks | 5 | 40 |
| | | | 50 | 10 | 60 | 15 | 10 | | |

## Examination Pattern

| Component | Duration in Hours | Marks | | | Total Marks |
|---|---|---|---|---|---|
| | | Practical Exam | Record | Weightage | |
| Test | 2 | 50 | - | 10 | 50 |
| Model | 3 | 60 | - | 15 | 60 |
| Experiments | - | - | - | 10 | 10 |
| Observation | - | - | - | 05 | 05 |
| Total Marks - CIA | | | | 40 | 40 |
| ESE | 3 | 50 | 10 | - | 60 |

## Components for and Distribution of Marks for ESE (Theory) Ability Enhancement Compulsory Courses (AECC) & Question Paper Pattern

| Duration in Hours | Mode of Exam | Type of Questions | No. of Questions | Marks |
|---|---|---|---|---|
| 2 | Online | MCQ | 50 | 50x1=50 |

**Department of Computer Science[PG]**