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	84	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		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	-	8	-	-	-	**8**
Total	**86**	**84**	**4**	**6**	**90**	**90**

Semester - 1

Curriculum

M.Sc. Computer Science

Semester – 1									
Course Code	Part	Course Category	Course Name	Hours / Week	Examination				Credits
					Duration in hrs.	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	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)	

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, 1st Edition, Manning Publications.	
2	Goodrich, (2022), Data Structures and Algorithms in Java, 6th Edition, Wiley.	
3	Skiena, (2008), The Algorithm Design Manual, 2nd 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	

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.

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

Course Code	Course Name	Category	Hours / Week	Credit
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	

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)	

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

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	
2	https://archive.nptel.ac.in/courses/106/105/106105172/	

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)	

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

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)	

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	

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)	

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

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 Outcome

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
I		**Presentation Skills**	
	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.	
II		**Confidence**	
	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.	

III	**Creativity**		
	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**

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