Bharatiya Vidya Bhavan

BHAVAN'S VIVEKANANDA COLLEGE

OF SCIENCE, HUMANITIES AND COMMERCE

Sainikpuri, Secunderabad

Autonomous College - Affiliated to Osmania University

Reaccredited with 'A' Grade by NAAC

Department of Computer Science

CBCS (w.e.f. 2026-27)

M.Sc. (Computer Science) SEMESTER-I

Paper	Code	Paper Title	PPW			Max Marks		Max Marks	Credits
			TH	T	PR	TH	TH-CIA	PR	
I	CS101	Advanced Java Programming	4			70	30		4
II	CS102	Operating Systems	4			70	30		4
III	CS103	Discrete Mathematics	4			70	30		4
IV	CS104	Software Engineering	4			70	30		4
V	CS101P	Advanced Java Programming Lab			4			50	2
VI	CS102P	Operating Systems Lab			4			50	2
VII	CS104P	Software Engineering Lab			4			50	2
VIII	CS105P	Python Programming Lab		1	2			50	2
		Total	**16**	**1**	**14**	**280**	**120**	**200**	**24**

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Department of Computer Science
CBCS (w.e.f. 2026-27)

SEMESTER-II

Paper	Code	Paper Title	PPW			Max Marks		Max Marks	Credits
			TH	T	PR	TH	TH-CIA	PR	
I	CS201	Design & Analysis of Algorithms	4			70	30		4
II	CS202	DevOps Methodologies	4			70	30		4
III	CS203	Data Science with Python	4			70	30		4
IV	CS204	Statistics for Machine Learning	4			70	30		4
V	CS201P	Design & Analysis of Algorithms Lab			4			50	2
VI	CS202P	DevOps Methodologies Lab			4			50	2
VII	CS203P	Data Science with Python Lab			4			50	2
VIII	CS205P	R Programming Lab		1	2			50	2
		Total	**16**	**1**	**14**	**280**	**120**	**200**	**24**

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M.Sc. (Computer Science) I Year
(w.e.f academic year: 2026-27)
Semester I

Course: Advanced Java Programming
Course Code: CS101

Hour (60 Hrs.)/ **Week:** 4PPW
Credits: 4

Course Objectives: The objectives of this course are,

1. To provide knowledge of advanced Java concepts including Collections Framework, Generics, Multithreading, and Java I/O.
2. To impart skills in database programming using JDBC and persistence using Hibernate/JPA.
3. To develop an understanding of networking concepts and client-server programming using Java APIs.
4. To enable students to design and develop dynamic web applications using Servlets, JSP, and MVC architecture.
5. To introduce RESTful web services and data handling techniques using JSON/XML.
6. To familiarize students with enterprise Java development using Spring Boot, microservices, security, and cloud concepts.

UNIT - I:
Collections Framework: Interfaces (List, Set, Map), Collection Classes (ArrayList, LinkedList, HashSet).Accessing a collection via an Iterator, Using an Iterator.
Generics: Simple Generics Examples, Concurrent Collections.
Java I/O & NIO.2: Streams – Byte Streams (InputStream, OutputStream, FileInputStream, FileOutputStream), Character Streams (Reader, Writer, FileReader, FileWriter), Serialization-Serializable, Externalizable, NIO Channels and Buffers.
Networking: INETAddress, URL, URLConnection.
(Book 2: Chapters:20,14,29,22,23,24)

UNIT - II:
JDBC: Drivers, JDBC Architecture, JDBC Classes and Interfaces, Basic steps – Loading a Driver, making a Connection, Execute SQL Statement, Types of SQL Statements, Retrieving Results, Scrollable and Updatable ResultSet, ResultSetMetadata.
Hibernate/JPA: Introduction to Hibernate, Entity Mapping – Writing POJO Class, Creating a Table, Writing a Hibernate Application, Compiling and Running an Application, Basic HQL Queries.
(Book 1: Chapters:22,23)

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UNIT - III:

Servlets: Architecture, Lifecycle, Passing Parameters to Servlets, Session Management-Cookies, Filters.

JSP: Introduction to JSP, JSP Architecture, Lifecycle, Exploring Directive Tags, Basic Syntax of Expression Language (EL), Types of EL Expressions, JSTL Core Tags, JSTL SQL Tags.

Restful Services: Simple REST APIs.

(Book 1: Chapter:20; Book 3: Chapters:10,11,14,16)

UNIT - IV:

Spring Boot: Overview, REST Controllers, Configuration, Deployment Basics.

Microservices: Concept and Architecture, Service Discovery Overview.

Security: Basics of Authentication and Authorization, Token-Based Authentication (JWT).

Emerging Trends: Cloud Readiness - Key aspects of Cloud Readiness, Cloud Deployment Concepts.

(Book 4: Chapters:1,6,5,19,13,4)

Course Outcomes: By the end of the course, the students will be able to,

CS101.CO1: Apply advanced Java concepts including Collections Framework, Generics, Multithreading, and Java I/O in application development.

CS101.CO2: Implement database-driven applications using JDBC and perform persistence using Hibernate/JPA.

CS101.CO3:Develop networking applications using Java APIs for effective client-server communication.

CS101.CO4:Design and implement dynamic web applications using Servlets, JSP, and MVC architecture.

CS101.CO5:Build RESTful web services and handle data exchange using JSON/XML.

CS101.CO6:Develop enterprise-level applications using Spring Boot and apply concepts of microservices, security, and cloud technologies.

Books:

1. Roy, Uttam K. *Advanced Java Programming*. 1st edition, Oxford University Press, 2025.
2. Schildt, Herbert. *Java: The Complete Reference*. 12th edition, McGraw Hill, 2021.
3. Kumar, Santosh K. *JDBC, Servlet and JSP Includes JSF and Design Patterns: Black Book*. 1st edition, DreamTech, 2014.
4. Walls, Craig. *Spring in Action*. 5th edition, Manning Publications, 2018.
5. Horstmann, Cay S. *Core Java, Volume II: Advanced Features*. 9th edition, Oracle Press, 2024.

Suggested Links:

1. **Security:** Basics of Authentication and Authorization, Token-Based Authentication (JWT): https://youtu.be/HYBRBkYtpeo?si=ZuSMuf-1x43Fj35o
2. **Cloud Readiness:**https://aws.amazon.com/what-is-cloud-computing/
3. **Spring Boot:** Overview, REST Controllers, Configuration, Deployment Basics. https://youtube.com/@genuinecoder?si=CUAmmwV-SSMV5qcj

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CO–PO Articulation Matrix

COs / POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CS101.CO1	3	3	1	3	2	1	1	2	2	2
CS101.CO2	3	3	1	3	2	1	1	2	2	2
CS101.CO3	3	3	2	3	3	1	1	2	2	2
CS101.CO4	3	3	2	3	3	1	1	3	2	2
CS101.CO5	3	3	1	3	2	1	1	2	2	2
CS101.CO6	3	3	2	3	3	2	2	3	3	3

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M.Sc. (Computer Science) I Year
(w.e.f academic year: 2026-27)
Semester I

Course: Operating Systems
Course Code: CS102

Hour (60 Hrs.)/ **Week:** 4PPW
Credits: 4

Course Objectives: The objectives of this course are,

1. To understand the fundamental concepts and functions of operating systems.
2. To analyze process management and concurrency mechanisms.
3. To study CPU scheduling and synchronization techniques.
4. To examine deadlock conditions and strategies for deadlock prevention, avoidance, detection, and recovery.
5. To understand memory management techniques including paging, virtual memory, page replacement, and mass-storage management.
6. To explore file systems, virtualization, and distributed file systems such as GFS and HDFS.

UNIT - I:

Introduction: What Operating Systems Do, Computer-System Architecture, Operating-System Operations, Resource Management, Security and Protection.

Operating System Structures: Operating Systems Services, System Calls, Linkers and Loaders, Operating System Design and Implementation, Operating System Structure.

Processes: Process Concept, Process Scheduling, Operations on Processes, Inter Process Communication, IPC in Shared Memory, IPC in Message-Passing Systems, Examples of IPC Systems (Pipes).

Threads & Concurrency: Overview, Multithreading Models.

(Book 1: Chapters:1,2,3,4)

UNIT- II:

CPU Scheduling: Basic Concepts, Scheduling Criteria, Scheduling Algorithms, Real-Time CPU Scheduling.

Synchronization Tools: Background, Critical-Section Problem, Peterson's Solution, Semaphores, Monitors.

Synchronization Examples: Classic Problems of Synchronization- The Bounded-Buffer Problem, The Reader's Writer's Problem, The Dining Philosopher's Problem.

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Deadlocks: System Model, Deadlock Characterization, Methods for Handling Deadlocks, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection, Recovery from Deadlock.
(Book 1: Chapters:5,6,7,8)

UNIT- III:
Main Memory: Contiguous Memory Allocation, Segmentation, Paging, Structure of the Page Table, Swapping.
Virtual Memory: Demand Paging, Page Replacement, Allocation of Frames, Thrashing.
Mass-Storage Structure: Overview of Mass Storage Structure, HDD/Disk Scheduling, Storage Device Management, Swap Space Management, RAID Structure.
(Book 1: Chapters:9,10,11;Book 2: Chapter:8)

UNIT - IV:
File Systems: File Concept, Access Methods, Directory Structure.
File System Implementation: File-System Structure, Directory Implementation, Allocation Methods, Free-Space Management, Recovery.
Virtual Machines: History, Benefits and Features, Building Blocks, Types of VMs and Implementation.
Networks And Distributed Systems: Advantages of Distributed Systems, Network Structure, Distributed File System- Cluster- Based Distributed File System. (Google File System, Hadoop Distributed File System)
(Book 1: Chapters:13,14,18,19)

Course Outcomes: By the end of the course, the students will be able to,

CS102.CO1: Explain the structure and functions of operating systems, including system calls and OS services.
CS102.CO2:Analyze and compare process scheduling algorithms and synchronization mechanisms for efficient CPU utilization.
CS102.CO3:Apply synchronization tools (semaphores, monitors) to solve classical process Synchronization problems.
CS102.CO4:Identify deadlock situations and evaluate appropriate handling techniques.
CS102.CO5:Evaluate memory management and virtual memory techniques such as paging, page replacement algorithms, and thrashing control.
CS102.CO6:Describe file system organization, virtualization concepts.

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Books:

1. Silberschatz, Abraham, Peter B. Galvin, and Greg Gagne. *Operating System Concepts*. 10th edition, Wiley, 2021.
2. Silberschatz, Abraham, Peter B. Galvin, and Greg Gagne. *Operating System Concepts*. 9th edition, Wiley, 2013.
3. Tanenbaum, Andrew S., and Herbert Bos. *Modern Operating Systems*. 4th edition, PearsonEducation, 2008.
4. Stallings,William. *Operating Systems*: *Internals and Design Principles*. 7th edition, Pearson Education, 2013.
5. Dhamdhere, Dhananjay M. *Operating Systems: A Concept-Based Approach*. 3rd edition, McGraw-Hill Education, 2017.
6. Arpaci-Dusseau, Remzi H., and Andrea C. Arpaci-Dusseau. *Operating Systems: Three Easy Pieces*. 1st edition, Arpaci-Dusseau Books, 2018.

CO–PO Articulation Matrix

COs / POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CS102.CO1	3	2	1	2	2	1	1	1	1	2
CS102.CO2	3	3	1	2	2	1	1	1	2	2
CS102.CO3	3	3	1	3	2	1	1	2	2	2
CS102.CO4	3	3	1	2	2	1	1	2	2	2
CS102.CO5	3	3	1	3	2	1	1	2	1	2
CS102.CO6	3	2	2	2	2	1	1	2	1	2

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M.Sc. (Computer Science) I Year
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Semester I

Course: Discrete Mathematics
Course Code: CS103

Hour (60 Hrs.)/ **Week:** 4PPW
Credits: 4

Course Objectives: The objectives of this course are,

1. To introduce the fundamentals of propositional logic, predicates, quantifiers, and methods of mathematical proof.
2. To develop understanding of Boolean algebra, logic gates, normal forms, and circuit minimization techniques using Boolean identities and K-maps.
3. To impart knowledge of combinatorial techniques including permutations, combinations, binomial theorem, and inclusion–exclusion principle.
4. To provide methods for solving recurrence relations using substitution, characteristic roots, and generating functions.
5. To familiarize students with graph theory concepts including graph representations, connectivity, Euler and Hamilton paths, and shortest path algorithms.
6. To introduce tree structures, traversal methods, spanning trees, and minimum spanning tree algorithms, Prim's and Kruskal's algorithms.

UNIT - I:

Propositional Logic: Propositional Logic, Propositional Equivalences, Predicates & Quantifiers, Rules of Inference-Valid Arguments in Propositional Logic, Rules of Inference for Quantified Statements. Introduction to Proofs-Direct Proofs, Proof by Contraposition, Proof by Contradiction.

Boolean Algebra: Boolean Functions and Its Representation, Logic Gates, Normal Forms-Disjunctive Normal Form, Conjunctive Normal Form, Minimizations of Circuits by using Boolean Identities and K-Map.

(Book 1: Chapters:1.1,1.2,1.3,1.5,1.6,1.7,10.1,10.2,10.3,10.4)

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UNIT - II:

Combinations and Permutations: Basics, Enumeration of Combinations and Permutations, Enumeration of Combinations and Permutations with Repetitions, Enumeration of Permutations with Constrained Repetitions, Binomial Coefficient- Pascal's Identity, Pascal's Triangle, Multinomial Theorem, The Principle of Inclusion-Exclusion and Its Applications.
(Book 2: Chapters:2.1 to 2.8)

UNIT - III:

Recurrence Relations: Generating Functions of Sequences, Generating Functions Model, Calculating Coefficients of Generating Functions, Solutions of Recurrence Relations, The Fibonacci Relation, Solving Recurrence Relations by Substitution and Generating Functions, Method of Characteristic Roots, Solution of Inhomogeneous Linear Recurrence Relations, The Method of Undetermined Coefficients Solving Nonlinear Recurrence Relations.
(Book 2: Chapters:3.1 to 3.6)

UNIT - IV:

Graphs: Graphs and Graph Models, Graph Terminology and Special Types of Graphs, The Handshaking Theorem, Representing Graphs and Graph Isomorphism, Connectivity of Graphs, Euler and Hamilton Paths and Circuits, Shortest Path Problems, Dijkstra's Algorithm, Planar Graphs–Euler's Formula.
Trees: Introduction to Trees, Tree Traversal, Spanning Trees, DFS, BFS Algorithms, Minimal Spanning Trees, Prim's, Kruskal's Algorithms.
(Book 1: Chapters:8.1 to 8.8,9.1,9.3,9.5)

Course Outcomes: By the end of the course, the students will be able to,

CS103.CO1: **Apply** rules of inference and proof techniques to construct and validate logical arguments.
CS103.CO2: **Analyze** and simplify Boolean functions using normal forms and Karnaugh maps.
CS103.CO3: **Solve** combinatorial problems using permutations, combinations, binomial theorem, and inclusion –exclusion principle.
CS103.CO4: **Formulate** and solve recurrence relations using generating functions and characteristic root methods.
CS103.CO5: **Analyze** properties of graphs and apply algorithms such as Dijkstra's to solve shortest path problems.
CS103.CO6: **Apply** tree traversal techniques and construct minimal spanning trees using DFS, BFS, Prim's, and Kruskal's algorithms.

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Books:

1. Rosen, Kenneth H. *Discrete Mathematics and Its Applications*. 7th edition, McGraw Hill Education (India) Pvt. Ltd., 2012.
2. Mott, Joe L., Abraham Kandel, and Theodore P. Baker. *Discrete Mathematics for Computer Scientists and Mathematicians*. 2nd edition, Prentice Hall of India Pvt. Ltd., 2008.
3. Lin, C. L., and D. P. Mohapatra. *Elements of Discrete Mathematics*. 3rd edition, McGraw Hill, 2008.
4. Grimaldi, Ralph P. *Discrete and Combinatorial Mathematics*. 5th edition, Pearson Education, 2019.

CO–PO Articulation Matrix

COs / POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CS103.CO1	3	3	1	1	2	2	1	1	1	2
CS103.CO2	3	3	1	3	2	1	1	2	1	2
CS103.CO3	3	3	1	2	2	1	1	2	1	2
CS103.CO4	3	3	1	2	2	1	1	2	1	2
CS103.CO5	3	3	2	3	2	1	1	3	2	2
CS103.CO6	3	3	2	3	2	1	1	3	2	2

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M.Sc. (Computer Science) I Year
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Semester I

Course: Software Engineering
Course Code: CS104

Hour (60 Hrs.)/ **Week:** 4PPW
Credits: 4

Course Objectives: The objectives of this course are,

1. To understand fundamental concepts and processes of software engineering.
2. To apply various SDLC models for software development.
3. To develop skills in requirements analysis and stakeholder identification.
4. To learn software design principles and architectural concepts.
5. To apply coding standards and software testing techniques.
6. To understand software quality assurance, configuration management, and maintenance practices.

UNIT - I:

Fundamentals of Software Engineering: Introduction to Software Engineering: The nature of Software, Software Application Domains, The Software Process, Software Engineering Practice. Software Engineering for AI systems (Modern AI System Components, Model Development & Evaluation, Data engineering and Quality).

Software Process Structure: A Generic Process Model, Process Framework, CMMI, Prescriptive Process Models: Waterfall Model, Incremental Process Models, Evolutionary Process Models – Prototyping, The Spiral Model, Concurrent Models; An agile view of Process: Agility, Agile Process and Agile Process Models –Extreme Programming (XP).
(Book 1: Chapter: 1 (1.1 to 1.4), Chapter: 2 (2.1 to 2.5), Chapter: 3 (3.1 to 3.5), Chapter: 4 (4.1 to 4.2, 4.3.1, 4.3.2), Chapter: 5 (5.1 to 5.3), Chapter: 6 (6.1 to 6.5))

UNIT - II:

Requirement Engineering: Understanding Requirements, Establishing the Groundwork, Requirement Engineering tasks, Initiating the Requirements Engineering Process, Eliciting Requirements, Feasibility Study, Software Requirements Analysis and Specification, Stakeholder Analysis using modern tools Introduction (Miro, Lucid Chart, Jira, Confluence).

Software Requirements, Problem Analysis, Requirements Specification: Software Requirements Specification document, UML Models that supplement the use case.

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Planning and managing the project: Managing Software Project, Project Personnel, Effort Estimation, Risk Management, the project plan, Software project estimation – Empirical estimation models.
(Book 1: Chapter: 7(7.1 to 7.7), Chapter: 8 (8.1 to 8.5), Chapter: 24 (24.1 to 24.5), Chapter: 25 (25.1 to 25.3), Chapter: 26 (26.1 to 26.5))

UNIT - III:
Design Engineering: Design Principles, Design Notation and Specification, Design concepts, Flow oriented modelling; The function-oriented design with case studies; OO Design Concepts.
Architectural Design:
Software Architecture, Data Design, Modelling Component-Level Design. A brief Taxonomy of Architectural Styles. Implementation: Coding Principles and Standards, Coding Process, Code Verification.
(Book 1: Chapter: 9 (9.1 to 9.3), Chapter: 10 (10.1 to 10.3), Chapter: 11 (11.1 to 11.3) Chapter: 12 (12.1, 12.2) Chapter: 13 (13.1, 13.2), Chapter: 14 (14.1 to 14.4))

UNIT - IV:
Software Testing Strategies: Unit, Integration, System, and Acceptance Testing, Testing techniques: White box testing – Path testing and structure testing; Black-box testing - Equivalence Partitioning, Boundary Value Testing; Test Automation, Continuous Integration (CI), Test-driven Development (TDD), Software Quality Assurance: Quality Planning, Reviews, Reliability, ISO Standards. AI-based Testing tools Introduction (AI based bug detection and analysis, test generating tools like Selenium, Cypress, Lambda Test)
Software Configuration Management (SCM): Version Control, Change Management, Configuration Audits. Software Evolution: Categories of Maintenance, Legacy System Management, Reengineering, Software Reuse.
(Book 1: Chapter: 15 (15.1 to 15.3), Chapter: 16 (16.1 to 16.3), Chapter: 17 (17.1 to 17.3), Chapter: 18 (18.1, 18.2), Chapter: 19 (19.1 to 19.3), Chapter: 20 (20.1 to 20.5), Chapter: 22 (22.1 to 22.3), Chapter: 27 (27.1 to 27.4))

Course Outcomes: By the end of the course, the students will be able to,

CS104.CO1:Explain software engineering principles and SDLC models.
CS104.CO2:Analyze and document software requirements effectively.
CS104.CO3:Design software systems using appropriate methodologies.
CS104.CO4:Apply coding standards and implementation practices.
CS104.CO5:Perform software testing using suitable techniques.
CS104.CO6:Apply quality assurance, configuration management, and maintenance practices.

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Books:

1. Pressman, Roger S., and Bruce R. Maxim. *Software Engineering: A Practitioner's Approach*. 9th edition,McGraw-Hill Education, 2023.
2. Sommerville, Ian. *Software Engineering*. 10th edition, Pearson, 2015.
3. Pfleeger, Shari Lawrence, and Joanne M. Atlee. *Software Engineering: Theory and Practice*. 4th edition,Pearson, 2010.
4. Jalote, Pankaj. *An Integrated Approach to Software Engineering*. 3rd edition, Springer, 2005.

Suggested Links:

1. https://ckaestne.github.io/seai/S2020/
2. https://simplystakeholders.com/resources/guides/stakeholder-analysis/
3. https://testguild.com/7-innovative-ai-test-automation-tools-future-third-wave/

CO–PO Articulation Matrix

COs / POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CS104.CO1	3	2	1	2	2	1	1	1	1	2
CS104.CO2	3	3	2	2	3	1	1	1	2	2
CS104.CO3	3	3	1	3	2	1	1	2	2	2
CS104.CO4	3	2	1	3	2	2	1	2	2	2
CS104.CO5	3	3	1	3	2	2	1	1	2	2
CS104.CO6	3	3	2	3	2	2	2	2	2	3

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Semester I

Course: Advanced Java Programming Lab — **Hour** (60 Hrs.)/ **Week:** 4PPW
Course Code: CS101P — **Credits:**2

Course Objectives: The objectives of this course are,

1. To provide hands-on practice with advanced Java concepts including collections, threads, I/O, and networking.
2. To develop skills in creating dynamic, database-driven applications using JDBC and Servlets/JSP.
3. To expose students to persistence frameworks (Hibernate/JPA) and RESTful services.
4. To build industry-ready mini-projects using modern Java frameworks.

List of Programs:

1. Write a program to demonstrate Collections Framework (List, Set, Map) with Generics and Iterators.
2. Write a program to implement multithreading with synchronization and Executor framework.
3. Write a program for file handling using Java I/O. (read, write, copy, serialization).
4. Write a program to demonstrate NIO.2 features: Path, Files, and WatchService API.
5. Write a program for client-server communication using TCP sockets.
6. Write a program for UDP-based client-server communication.
7. Write a program using JDBC to connect to a database, insert, update, and retrieve records.
8. Implement a transaction management example using JDBC.
9. Write a program using Hibernate/JPA to map an entity and perform CRUD operations.
10. Develop a simple Servlet to handle HTTP requests and responses.
11. Develop a program to demonstrate the Servlet Life Cycle.
12. Develop a Servlet-based login application using session management (cookies/HttpSession).
13. Create a JSP application to perform form handling and display dynamic results.
14. Implement a JSP + Servlet MVC application (e.g., student record management).
15. Develop a REST API in Java (using JAX-RS or Spring Boot) that returns JSON data.

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16. Mini Project: Develop a small database-driven web application (e.g., online student portal, library management, or employee management system) integrating Servlets/JSP, JDBC/Hibernate, and REST API basics.
17. Implement a simple token-based authentication (JWT) in a REST API.

Course Outcomes: By the end of the course, the students will be able to,

CS101P.CO1:Apply advanced Java programming constructs (Collections, Threads, I/O, Networking) through hands-on practice.
CS101P.CO2:Design and implement dynamic web applications using Servlets and JSP.
CS101P.CO3:Connect applications with databases using JDBC and ORM (Hibernate/JPA).
CS101P.CO4:Develop mini-projects demonstrating REST APIs and basic enterprise Java development.

CO–PO Articulation Matrix

COs / POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CS101P.CO1	3	3	1	3	2	1	1	2	2	2
CS101P.CO2	3	3	1	3	3	1	1	2	2	2
CS101P.CO3	3	3	1	3	2	1	1	2	2	2
CS101P.CO4	3	3	2	3	3	2	1	3	3	3

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M.Sc. (Computer Science) I Year
(w.e.f academic year: 2026-27)
Semester I

Course: Operating Systems Lab | **Hour** (60 Hrs.)/ **Week:** 4PPW
Course Code: CS102P | **Credits:** 2

Course Objectives: The objectives of this course are,

1. To provide hands-on experience with Linux shell scripting and system calls for system information and process management.
2. To implement and analyze CPU scheduling, disk scheduling, and process synchronization techniques through simulation programs.
3. To design and simulate memory management and deadlock handling techniques in operating systems.
4. To study and analyze real-world operating systems, including Linux, Windows, mobile OS, and cloud-based systems through case studies.

List of Programs:

1. Write a shell script to display system information (date, time, user details, memory and disk usage).
2. Write a shell program to display the multiplication table of a given number using loops.
3. Write a shell script to perform basic arithmetic operations on two numbers entered by the user.
4. Write a C program using process-related system calls like fork(), getpid(), getppid(), wait(), and exit().
5. Write a C program to simulate inter-process communication using pipe() system call.
6. Write a C program to demonstrate FCFS and SJF CPU scheduling algorithms.
7. Write a C program to demonstrate Priority and Round Robin CPU scheduling using given burst time and arrival times.
8. Write a C program to implement the Producer–Consumer problem using semaphores.
9. Write a C program to implement the Readers–Writer's problem using semaphores and shared memory.
10. Write a C program to implement the Dining Philosophers problem using synchronization techniques.

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11. Write a C program to simulate Banker's algorithm for deadlock avoidance.
12. Write a C program to demonstrate deadlock prevention using resource ordering.
13. Write a C program to simulate contiguous memory allocation using First Fit, Best Fit, and Worst Fit techniques.
14. Write a C program to simulate page replacement algorithms: FIFO, LRU, and Optimal.
15. Write a C program to simulate disk scheduling algorithms: FCFS and SSTF.
16. Write a C program to simulate disk scheduling algorithms: SCAN and C-SCAN.
17. Write a C program to simulate file allocation strategies: Sequential, Linked, and Indexed.
18. Case Studies on: Linux OS, Windows 10, iOS, Android OS, Cloud OS.

Course Outcomes: By the end of the course, the students will be able to,

CS102P.CO1:Apply shell scripting and system calls to perform system-level operations and process management tasks.
CS102P.CO2:Analyze and implement CPU scheduling and process synchronization algorithms using C programming.
CS102P.CO3:Evaluate deadlock handling techniques and memory management algorithms such as paging and allocation strategies.
CS102P.CO4:Examine file systems, disk scheduling, segmentation, and operating system case studies including Linux, Windows, mobile OS, and cloud OS.

CO–PO Articulation Matrix

COs / POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CS102P.CO1	3	3	1	3	2	1	1	2	2	2
CS102P.CO2	3	3	1	3	2	1	1	2	2	2
CS102P.CO3	3	3	1	3	2	1	1	2	2	2
CS102P.CO4	3	2	2	3	2	1	1	2	2	2

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Semester I

Course: Software Engineering Lab — **Hour** (60 Hrs.)/ **Week:** 4PPW
Course Code: CS104P — **Credits:** 2

Course Objectives: The objectives of this course are,

1. To provide hands-on experience in applying software engineering principles.
2. To practice modelling requirements, design, and architecture using UML diagrams.
3. To use StarUML/Edraw Max/Draw.io/MS Visio (or equivalent CASE tools) for preparing different software models.
4. To implement selected system layers for real-world projects.

Lab Experiments: Students shall perform the following exercises for any two projects selected from the list of sample projects:

1. Identify Use Cases and develop the Use Case Model.
2. Identify the business activities and develop a UML Activity Diagram.
3. Identify the conceptual classes and develop a Domain Model with UML Class Diagram.
4. Using the identified scenarios, find the interaction between objects and represent them using UML Interaction Diagrams (Sequence / Communication).
5. Draw the State Chart Diagram.
6. Identify the User Interface, Domain Objects, and Technical Services. Draw the partial layered Logical Architecture Diagram with UML Package Diagram notation.
7. Implement the Technical Services Layer.
8. Implement the User Interface Layer.
9. Draw Component and Deployment Diagrams.

List of Sample Projects:

1. ATM Application
2. Library Management System
3. Railway Reservation System
4. E-Commerce System
5. Banking System
6. Passport Automation System
7. Stock Maintenance System
8. E-Ticketing System
9. Online Exam Registration System
10. Online Course Reservation System

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Course Outcomes: By the end of the course, the students will be able to,

CS104P.CO1: Model software requirements and designs using UML notations.
CS104P.CO2: Prepare Use Case, Activity, Class, Interaction, State, Component, and deployment diagrams using StarUML/Edraw Max/Draw.io/MS Visio.
CS104P.CO3: Understand layered software architecture by identifying UI, domain objects, and technical services.
CS104P.CO4: Implement the User Interface and Technical Service layers for sample projects.

CO–PO Articulation Matrix

COs / POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CS104P.CO1	3	2	1	3	2	1	1	2	2	2
CS104P.CO2	3	2	1	3	2	1	1	1	2	2
CS104P.CO3	3	3	1	2	2	1	1	2	1	2
CS104P.CO4	3	3	1	3	2	2	1	2	3	2

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(w.e.f academic year: 2026-27)
Semester I

Course: Python Programming Lab | **Hour** (45Hrs.)/**week:**(2P+1T) PPW
Course Code: CS105P | **Credits:** 2

Course Objectives: The objectives of this course are,

1. To introduce the fundamentals of Python programming through hands-on practice.
2. To develop problem-solving skills using Python constructs such as data types, control structures, functions, and file handling.
3. To train students in the use of built-in data structures such as lists, tuples, sets, and dictionaries.
4. To enable students to develop simple Python applications using object-oriented concepts and basic GUI programming for real-world problem-solving.

List of Programs:

1. Write a Python program to demonstrate basic input/output operations and use of variables.
2. Write Python programs to apply control structures (if, elif, else) and loops (for, while).
3. Write a Python program to generate Fibonacci series, prime numbers, and factorial using functions.
4. Write a program to demonstrate Arrays using NumPy, Slicing and Indexing in NumPy Arrays Matrices in NumPy.
5. Write a Python program to demonstrate recursion.
6. Write Python programs to manipulate strings (slicing, searching, replacing, reversing, palindrome check).
7. Write a Python program using regular expressions for pattern matching.
8. Write programs using lists: insertion, deletion, searching, sorting, and matrix operations.
9. Write programs using tuples and sets: operations, membership, union, intersection, difference.
10. Write programs using dictionaries: key-value operations, updating, and nested dictionaries.
11. Write a Python program to demonstrate list comprehensions and lambda functions.

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12. Write Python programs to handle exceptions (try, except, finally, raise, custom exceptions).
13. Write programs to read from and write to text files.
14. Write programs using Python modules and packages. (import math, random, statistics, datetime).
15. Write a Python program to demonstrate simple object-oriented concepts.(classes, objects, constructors, methods, inheritance).
16. Write a Python program to create a simple GUI window with labels, buttons, and basic layout.
17. Write a Python GUI program to make calculator (e.g., addition of two numbers).
18. Write a GUI program to convert Celsius temperature to Fahrenheit.
19. Mini Project: Develop a small Python application.

Course Outcomes: By the end of the course, the students will be able to,

CS105P.CO1: Write, debug, and execute Python programs for basic computational problems using appropriate programming constructs.
CS105P.CO2: Apply control structures, functions, and modular programming techniques to develop problem-solving solutions.
CS105P.CO3: Use built-in data structures such as lists, tuples, sets, and dictionaries effectively for problem-solving.
CS105P.CO4: Develop simple Python applications using file handling, exception management, and object-oriented concepts.

Books:

1. Thareja, Reema. *Python Programming: Using Problem Solving Approach*. 1st edition, Oxford University Press, 2017.
2. Lutz, Mark. *Learning Python*. 5th edition, O'Reilly Media, Inc., 2013.
3. Downey, Allen B. *Think Python: How to Think Like a Computer Scientist*. 2nd edition, Green Tea Press, 2015.

CO–PO Articulation Matrix

COs / POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CS105P.CO1	3	3	1	3	2	1	1	1	2	2
CS105P.CO2	3	3	1	3	2	1	1	2	2	2
CS105P.CO3	3	3	1	3	2	1	1	2	2	2
CS105P.CO4	3	3	1	3	3	1	1	3	2	2

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Semester II

Course: Design & Analysis of Algorithms — **Hour** (60 Hrs.)/ **Week:** 4PPW
Course Code: CS201 — **Credits:** 4

Course Objectives: The objectives of this course are,

1. To learn about the fundamentals of algorithms and problem types.
2. To understand the working of different sorting and searching algorithms.
3. To illustrate different approaches to problem solving through relevant algorithms.
4. To analyze the limitations of algorithm power.
5. To evaluate the merits and demerits of Dynamic Programming and Greedy Technique.
6. To create a discernible knowledge base for designing and analyzing algorithms.

UNIT - I:

Introduction: Algorithm, Fundamentals of Algorithmic Problem Solving, Important Problem Types.
Algorithm Specification: Pseudocode Conventions.
Performance Analysis: Space Complexity, Time Complexity, Asymptotic Notations, Practical Complexities, Performance Measurement.
Fundamentals of the Analysis of Algorithms: The Analysis Framework, Basic Efficiency Classes, Mathematical Analysis of Non-Recursive and Recursive Algorithms.
Brute Force Search: Selection Sort, Bubble Sort, Sequential Search, Brute-Force String Matching, Exhaustive Search, Depth-First Search, Breadth-First Search.
(Book 1: Chapters: 1, 2, 3; Book 2: Chapter:1)

UNIT - II:

Decrease-and-Conquer: Insertion Sort, Topological Sorting, Binary Search, Interpolation Search.
Divide-and-Conquer: Merge Sort, Quick Sort, Multiplication of Large Integers, Strassen's Matrix Multiplication.
Transform-and-Conquer: Pre-Sorting, Balanced Search Trees, Heaps and Heap Sort, Problem Reduction.
Space and Time Trade-Offs: Hashing, B-Trees.
(Book 1: Chapters: 4, 5, 6, 7)

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UNIT - III:

Dynamic Programming: Knapsack Problem and Memory Functions, Optimal Binary Search Trees, Warshall's and Floyd's Algorithms.

Greedy Technique: Prim's Algorithm, Kruskal's Algorithm, Dijkstra's Algorithm, Huffman Trees.

Iterative Improvement: The Simplex Method, Maximum-Flow Problem.

(Book 1: Chapters: 8, 9, 10)

UNIT - IV:

Limitations of Algorithm Power: Lower-Bound Arguments, Decision Trees, P, NP, and NP-Complete Problems.

Backtracking: N-Queens Problem, Hamiltonian Circuit Problem, Subset-Sum Problem.

Branch-and-Bound: Assignment Problem, Knapsack Problem, Traveling Salesman Problem.

Approximation Algorithms for NP-Hard Problems: Approximation Algorithms for NP-Hard Problems, The Travelling Salesman Problem and Knapsack Problem.

(Book 1: Chapters: 11, 12)

Course Outcomes: By the end of the course, the students will be able to,

CS201.CO1: Explain the fundamentals of algorithms and problem types.
CS201.CO2: Comprehend the working of different sorting and searching algorithms.
CS201.CO3: Illustrate different approaches to problem solving through relevant algorithms.
CS201.CO4: Analyze the limitations of algorithm power.
CS201.CO5: Evaluate the merits and demerits of Dynamic Programming and Greedy Technique.
CS201.CO6: Create a discernible knowledge base for designing and analyzing algorithms.

Books:

1. Levitin, Anany. *Introduction to the Design and Analysis of Algorithms*. 3rd edition, Pearson, 2017.
2. Horowitz, Ellis, et al. *Fundamentals of Computer Algorithms*. 2nd edition, Universities Press, 2018.
3. Neapolitan, Richard E. *Foundations of Algorithms*. 5th edition, Jones & Bartlett Learning, 2015.
4. Cormen, Thomas H., et al. *Introduction to Algorithms*. 3rd edition, MIT Press, 2009.
5. Aho, Alfred V., et al. *The Design and Analysis of Computer Algorithms*. 1st edition, Addison-Wesley, 1974.
6. Knuth, Donald E. *The Art of Computer Programming*. Vols. 1–4, 3rd edition, Addison-Wesley, 1997.

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CO–PO Articulation Matrix

COs / POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CS201.CO1	3	2	1	1	1	1	1	1	1	2
CS201.CO2	3	3	1	2	1	1	1	1	1	2
CS201.CO3	3	3	1	2	1	1	1	2	1	2
CS201.CO4	2	3	2	1	1	1	1	1	1	2
CS201.CO5	3	3	1	2	1	1	1	2	1	2
CS201.CO6	3	3	1	2	2	1	1	2	2	3

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Semester II

Course: DevOps Methodologies | **Hour** (60 Hrs.)/ **Week:** 4PPW
Course Code: CS202 | **Credits:** 4

Course Objectives: The objectives of this course are,

1. To explain DevOps principles, Agile methodologies, and IT service management (ITIL) in modern software development.
2. To analyze DevOps lifecycle, architectures, and continuous integration/deployment pipelines.
3. To explore software architectures including monolithic, microservices, and containerized systems.
4. To apply version control systems and collaborative development practices using Git-based tools.
5. To study CI/CD pipelines, build systems, and Infrastructure as Code (IaC) for automation.
6. To evaluate DevOps culture, DevSecOps practices, monitoring systems, and emerging trends such as AIOps and MLOps.

UNIT - I:
Foundations of DevOps and Agile Practices: Introduction to DevOps, Agile, and ITIL, Agile Methodologies: Scrum, Kanban, Lean Principles, Agile Development Model and DevOps Principles and Practices, DevOps Lifecycle and Continuous Delivery Concepts, Release Management, Bottlenecks, Delivery Pipelines, Relationship between Development, QA, and Operations, Case Studies of DevOps Adoption.
(Book 1: Chapters:1,2,3; Book 2: Chapters:2,3)

UNIT - II:
DevOps Architectures, Models, and Source Control:
DevOps Models: Monolithic vs. Microservices, Architecture Rules of Thumb and Separation of Concerns,Resilient and Loosely Coupled Architecture Continuous Testing and Monitoring Strategies, Database Migrations in DevOps Environments and Data Tier in DevOps.

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Source Control: Git, GitHub, Gitlab, Bitbucket, Pull Request Workflows, Gerrit, Hosted Git Servers,
Containerization Basics: Docker and Kubernetes.
(Book 1: Chapters:3,4,5,6; Book 2: Chapters:4,5,6)

UNIT - III:
Continuous Integration, Deployment, and Automation:
CI/CD Pipeline Design and Implementation, Build Systems: Jenkins, GitLab CI/CD, CircleCI, Build Triggers, Job Chaining, Dependency-Based Builds **Infrastructure as Code** (IaC)–Puppet, Chef, Ansible, SaltStack, Terraform.
Cloud-Native DevOps: AWS, Azure, GCP Integration, Testing Automation: Selenium, PyTest, JUnit, Mocha TDD (Test-Driven Development), BDD (Behavior-Driven Development), Continuous Quality and System Health Monitoring.
(Book 1: Chapters:7,8,9; Book 2: Chapters:7,8,9,10)

UNIT - IV:
Advanced DevOps Practices and Cultural Transformation:
Continuous Delivery Best Practices (DevSecOps, Trunk-Based Development, Data Security),Build Infrastructure Basics: Host Systems, Build Servers, Value Stream Mapping and Customer Feedback Loops, Lean Management: Limiting WIP, Lightweight Change Approvals.
Cultural Transformation: Collaboration, Generative Culture, Transformational Leadership, Becoming a Learning Organization, Making Work Meaningful, DevOps Maturity Assessment Models and Visualization of Progress.
Future of DevOps: AIOps, MLOps, GitOps, NoOps.
(Book 1: Chapters:10,11,12; Book 2: Chapters:11,12,13)

Course Outcomes: By the end of the course, the students will be able to,

CS202.CO1: Explain DevOps concepts, Agile practices, and IT service management principles.
CS202.CO2: Analyze DevOps workflows, lifecycle stages, and CI/CD pipeline architectures.
CS202.CO3:Apply modern architectural approaches including microservices and containerization.
CS202.CO4: Implement version control and collaborative workflows using distributed systems like Git.
CS202.CO5: Design CI/CD pipelines and automate infrastructure using IaC tools and cloud platforms.
CS202.CO6: Evaluate DevOps maturity, cultural transformation, and emerging technologies in real-world scenarios.

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Books:

1. Verona, Joakim. *Practical DevOps*. 2nd edition, Packt Publishing Ltd., 2018.
2. Gaikwad, Deepak, and Viral Thakkar. *DevOps Tools from Practitioner's Viewpoint*. 1st edition, Wiley, 2019.
3. Bass, Len, Ingo Weber, and Liming Zhu. *DevOps: A Software Architect's Perspective*. 1st edition, Addison-Wesley, 2015.
4. Kim, Gene, et al. *The DevOps Handbook*. 1st edition, IT Revolution Press, 2016.
5. Humble, Jez, and David Farley. *Continuous Delivery*. 1st edition, Addison-Wesley, 2010.
6. Forsgren, Nicole, Jez Humble, and Gene Kim. *Accelerate: The Science of Lean Software and DevOps*. 1st edition, IT Revolution Press, 2018.

Suggested URL:

All the Ops: DevOps, DataOps, MLOps, and AIOps

CO–PO Articulation Matrix

COs / POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CS202.CO1	3	2	1	2	2	1	1	1	1	2
CS202.CO2	3	3	1	3	2	1	1	2	1	2
CS202.CO3	3	3	1	3	2	1	1	2	2	2
CS202.CO4	3	3	1	3	3	1	1	2	3	2
CS202.CO5	3	3	1	3	3	1	1	3	2	3
CS202.CO6	3	3	2	2	3	2	2	3	2	3

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Semester II

Course: Data Science with Python
Course Code: CS203

Hour (60 Hrs.)/ **Week:** 4PPW
Credits: 4

Course Objectives: The objectives of this course are,

1. Understand fundamentals of Data Science and its link to AI and ML.
2. Develop Python skills for data handling and analysis.
3. Apply statistical methods for data interpretation.
4. Perform data preprocessing and visualization.
5. Implement machine learning models and evaluate performance.
6. Understand basics of deep learning and its applications.

UNIT - I:

Introduction to Data Science:
Definition and Scope of Data Science, Evolution of Data Science, Data Science Lifecycle, Data Structure Types: Structured, Semi-Structured, Unstructured, Types of Data Analysis: Univariate, Bivariate, Multivariate, Difference between Data Analytics and Data Science.

Motivation and Applications:
Role of Data Science in Academia and Industry, Applications of Data Science, Difference between Artificial Intelligence, Machine Learning, and Data Science, Open Datasets (Kaggle, UCI, Government Portals).

Python for Data Science:
File Handling: CSV, Text Files, Binary Files, Introduction to Web Scraping, Fetching Web Data Using BeautifulSoup and Requests, Parsing HTML and Extracting Data.
(Book1: Chapter:7; Book2: Chapter:5; Appendix B; Book3: Chapters:1,2,3)

UNIT - II:

Data Analysis with Python: NumPy: Arrays, Indexing, Slicing, Array Operations, Basic Linear Algebra, Pandas: Series and Data Frames, Data Loading and Inspection, Grouping and Aggregation.

Statistical Foundations: Types of Data (Categorical, Numerical), Descriptive Statistics, Measures of Central Tendency (Mean, Median, Mode), Measures of Dispersion (Variance, Standard Deviation).

Data Pre-Processing: Data Cleaning, Handling Missing Values, Normalization and Standardization, Feature Scaling.

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Data Visualization: Introduction to Matplotlib, Seaborn, Visualization Techniques: Scatter Plots, Bar Charts, Histograms, Boxplots, Heatmaps and Correlation Matrices, Visual Data Exploration.
(Book 1: Chapters:4,5,6; Book 2: Chapters:6,7,9,10; Book 3: Chapter:5)

UNIT - III:
Machine Learning Foundations: Introduction to Machine Learning, Types of Machine Learning, Supervised, Unsupervised, Introduction to Reinforcement Learning, Overfitting and Underfitting, Bias-Variance Trade-Off, Supervised Learning Algorithms: Linear Regression, Logistic Regression, K-Nearest Neighbors (KNN), Decision Trees, Unsupervised Learning: K-Means Clustering, Feature Selection Basics.

Model Building with Python: Introduction to Scikit-Learn, Data Splitting (Train-Test Split), Model Training and Prediction.

Performance Measures: Cross-Validation, Confusion Matrix, Accuracy, Precision and Recall, F1-Score, Precision/Recall Trade-Off, The ROC Curve and AUC.
Neural Network Fundamentals: The Perceptron Model, The Multi-Layer Perceptron and Backpropagation, Activation Functions (Relu, Sigmoid, Tanh), Loss Functions, Regression vs. Classification Mlps.
(Book 4:Chapters:1,3,6,8,9,10;Book 1:Chapters:10,11,12,13;Book 2:Chapter:8;Book 3: Chapters: 11,12,17,18,19,25)

UNIT - IV:
Introduction to TensorFlow and Keras: Introduction to TensorFlow and Keras, Using TensorFlow Like NumPy, Building Simple Neural Network Models, Custom Loss Functions, Custom Activation Functions.
Deep Learning Architectures:
Convolutional Neural Networks (CNN): Convolution Operation, Kernels/Filters and Feature Maps, Stride and Padding, Convolutional Layers, CNN Architectures (Lenet, Alexnet, VGG, Resnet), Applications of CNN: Image Classification, Object Detection, Face Recognition, Medical Image Analysis.
Recurrent Neural Networks (RNN): Sequential Data and Time-Series Modeling, Recurrent Connections and Hidden States, Working of RNN, Limitations of RNN, Applications of RNN:
Natural Language Processing (Text Classification, Sentiment Analysis), Speech Recognition, Time-Series Forecasting.
(Book 4: Chapters:10,11,12,14,15)

Course Outcomes: By the end of the course, the students will be able to,

CS203.CO1: Explain fundamental concepts of Data Science and its relationship with AI and Machine Learning.
CS203.CO2: Apply Python techniques for data collection, processing, and analysis.
CS203.CO3: Perform statistical analysis and interpret data using appropriate measures.
CS203.CO4: Implement data pre-processing and visualization techniques for exploratory analysis.
CS203.CO5: Build and evaluate machine learning models using standard algorithms.
CS203.CO6: Demonstrate basic understanding of deep learning models and their applications.

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Books:

1. Thareja, Reema. *Data Science and Machine Learning Using Python*. 2nd edition, McGraw Hill, 2025.
2. McKinney, Wes. *Python for Data Analysis*. 3rd edition, O'Reilly, 2022.
3. Grus, Joel. *Data Science from Scratch*. 2nd edition, O'Reilly, 2019.
4. Géron, Aurélien. *Hands-On Machine Learning with Scikit-Learn and TensorFlow*. 3rd edition,
   O'Reilly, 2023.
5. Kroese, Dirk P., et al. *Data Science and Machine Learning: Mathematical and Statistical Methods*, 1st edition, CRC Press, 2024.

Suggested Link:

1. https://www.ibm.com/think/topics/data-science
2. https://aws.amazon.com/what-is/data-science/
3. https://www.ibm.com/think/topics/artificial-intelligence

Data Sets

4. https://www.kaggle.com/datasets
5. https://archive.ics.uci.edu/ (UCI Machine Learning Repository)

Government Open Data Portals

6. https://www.data.gov.in/ (India)
7. https://data.gov/ (USA)
8. https://data.europa.eu/en (European)

CO–PO Articulation Matrix

COs / POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CS203.CO1	3	2	1	1	1	1	1	1	1	2
CS203.CO2	3	3	1	3	2	1	1	1	1	2
CS203.CO3	3	3	1	2	2	1	1	1	1	2
CS203.CO4	2	3	1	3	2	1	1	1	2	2
CS203.CO5	3	3	2	3	3	1	1	2	2	2
CS203.CO6	2	2	2	3	2	1	1	2	1	3

1 → Low Correlation 2 → Medium Correlation 3 → High Correlation

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M.Sc. (Computer Science) I Year
(w.e.f academic year: 2026-27)
Semester II

Course: Statistics for Machine Learning
Course Code: CS204

Hour (60 Hours)**/week:** 4 PPW
Credits: 4

Course Objectives: The objectives of this course are,

1. Understand types of random variables, their probability distributions, and related computational techniques.
2. Estimate population parameters and apply various hypothesis testing methods to infer statistical conclusions.
3. Understand the mechanisms of data simulation and parameter estimation methodologies, including Maximum Likelihood Estimation and Bayesian Estimation.
4. Analyze and differentiate between linear and logistic regression models for predictive analysis.
5. Explore dimensionality reduction techniques like Principal Component Analysis (PCA) and foundational classification concepts.
6. Explore advanced machine learning techniques focusing on kernel methods for complex classification and dimensionality reduction.

UNIT - I:

Basics of Probability Theory: Basics of Probability, Bayes' Theorem, Random Variables (Discrete and Continuous), Probability Distributions, Expectation and Variance (Binomial, Poisson, Uniform, Normal and Exponential Distributions – Concepts and Applications only). **Inequalities and Limit Theorems:** Markov and Chebyshev Inequalities, Law of Large Numbers and Central Limit Theorem (Concepts only).

UNIT - II:

Data Simulation in Parametric Setup: Random Number Generation for Discrete (Uniform, Binomial, Poisson) and Continuous (Uniform, Normal, Exponential) Random Variables, Acceptance–Rejection Method, Estimation of Model Parameters using the Method of Moments and Maximum Likelihood Estimation (MLE) (Simple Examples only), Concept and Interpretation of Confidence Intervals (C.I.), Introduction to Bayesian Estimation (Concepts only).

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UNIT - III:

Statistical Inference and Regression Models: Hypothesis Testing, Concept of Null and Alternative Hypotheses, p-value and Level of Significance; z-test, t-test, Chi-square test, and F-test (Concepts and Applications).

Linear Models: Simple Linear Regression and Multiple Linear Regression,
Basic Idea of Significance Testing in Regression.

UNIT - IV:

Machine Learning Techniques: Introduction to Logistic Regression and Models with Binary Response Variables, Estimating and Interpreting Parameters in Logistic Regression (Application-Oriented), Basics of Classification and Density Estimation, Classification using Support Vector Machines (SVM), Clustering using the K-Means Algorithm, Dimensionality Reduction using Principal Component Analysis (PCA), Introduction to Kernel Methods, Kernel Classifiers and Kernel PCA (Conceptual Overview).

Course Outcomes: By the end of the course, the students will be able to,

CS204.CO1: Apply the basics of probability to calculate posterior probabilities, distributions, boundary limits and expected random outcomes.

CS204.CO2: Generate random numbers for discrete and continuous variables.

CS204.CO3: Estimate the population parameter and test its significance level by using various test statistics.

CS204.CO4: Predict the response variable and test the significance of the parameters for Multiple Linear Regression (MLR) or Logistic Regression (LR) or both.

CS204.CO5: Apply dimensionality reduction using Principal Component Analysis (PCA) and perform clustering and classification using k-means and Support Vector Machine (SVM).

CS204.CO6: Apply kernel methods, including kernel classifiers and Kernel PCA, to handle non-linear data.

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Books:

1. Ross, Sheldon. *Probability and Statistics for Engineers and Scientists*. 5th edition, Academic Press, 2014.
2. Sugiyama, Masashi. *Introduction to Statistical Machine Learning*. 1st edition, Elsevier, 2016.
3. Das Gupta, Anirban. *Probability for Statistics and Machine Learning: Fundamentals and Advanced Topics*. 1st edition, Springer, 2011.
4. Casella, George, and Roger L. Berger. *Statistical Inference*. 2nd edition, Thomson Learning, 2002.
5. James, Gareth, et al. *An Introduction to Statistical Learning with Applications in R*. 1st edition, Springer, 2013.
6. Montgomery, Douglas C., et al. *Introduction to Linear Regression Analysis*. 5th edition, Wiley, 2012.
7. Srinivasaraghavan, Anuradha, and Vincy Joseph. *Machine Learning*. 1st edition, Wiley, 2023.
8. Alpaydin, Ethem. *Introduction to Machine Learning*. 4th edition, MIT Press, 2020.
9. Theobald, Oliver. *Machine Learning*. 1st edition, Scatterplot Press, 2021.
10. Nageswara Rao, R. *Machine Learning in Data Science Using Python*. 1st edition, Dreamtech Press, 2022.

CO–PO Articulation Matrix

COs / POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CS204.CO1	3	3	1	2	1	1	1	1	1	2
CS204.CO2	3	3	1	3	2	1	1	2	1	2
CS204.CO3	3	3	1	2	2	1	1	1	1	2
CS204.CO4	3	3	1	3	2	1	1	2	1	3
CS204.CO5	3	3	1	3	2	1	1	2	2	3
CS204.CO6	3	3	1	3	2	1	1	2	1	3

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M.Sc. (Computer Science) I Year
(w.e.f academic year: 2026-27)
Semester II

Course: Design & Analysis of Algorithms Lab — **Hour** (60 Hrs.)/ **Week:** 4PPW
Course Code: CS201P — **Credits:** 2

Course Objectives: The objectives of this course are,

1. Understand fundamental algorithm design techniques such as sorting, searching, graph traversal, and backtracking through practical implementation.
2. Develop analytical skills to evaluate algorithm efficiency in terms of time and space complexity.
3. Apply different algorithmic strategies including divide and conquer, greedy methods, dynamic programming, and branch and bound.
4. Solve real-world computational problems using appropriate algorithms for optimization and graph-based applications.

List of Programs:

1. Write a program for sorting a given list using Selection Sort.
2. Write a program for sorting a given list using Bubble Sort.
3. Write a program to find a given number in a list using Sequential Search.
4. Write a program to perform Breadth First Search (BFS) traversal and Depth First Search (DFS) traversal on a graph (The graph represented should support either Adjacency List or Adjacency Matrix).
5. Write a program for sorting a given list using Insertion Sort.
6. Write a program for sorting a given list using Merge Sort.
7. Write a program for sorting a given list using Quick Sort.
8. Write a program for calculating time and space complexity of Linear Search algorithm.
9. Write a program for calculating time and space complexity of Quicksort algorithm.
10. Write a program for sorting a given list using Heap Sort.
11. Write a program to find a given number in a list using Binary Search.
12. Write a program to compute transitive closure of a directed graph using Warshall's algorithm.
13. Write a program to compute All-Pairs Shortest Paths using the Floyd's algorithm.

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14. Write a program to find the Minimum Spanning Tree for a weighted using Prim's Algorithm.
15. Write a program to find the single source shortest path in a weighted graph using Dijkstra's
    Algorithm.
16. Write a program to find n-Queens Problem using backtracking.
17. Write a program to find the Hamiltonian Circuit for a Weighted Graph.
18. Write a program to solve the Traveling Salesman Problem using Branch and Bound Technique.
19. Write a program to solve the 0/1 Knapsack Problem using Backtracking.

Course Outcomes: By the end of the course, the students will be able to,

CS201P.CO1: Implement and analyze sorting and searching algorithms such as Bubble Sort, Quick Sort, Merge Sort, Linear Search, and Binary Search.

CS201P.CO2: Design and apply graph algorithms including BFS, DFS, shortest path algorithms, and minimum spanning tree techniques.

CS201P.CO3: Develop solutions using advanced algorithmic paradigms like backtracking, branch and bound, and dynamic programming.

CS201P.CO4: Evaluate algorithm performance and select appropriate techniques to solve complex computational problems efficiently.

CO–PO Articulation Matrix

COs / POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CS201P.CO1	3	3	1	3	2	1	1	1	1	2
CS201P.CO2	3	3	1	3	2	1	1	2	2	2
CS201P.CO3	3	3	1	3	2	1	1	2	2	3
CS201P.CO4	3	3	1	2	2	1	1	2	1	3

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M.Sc. (Computer Science) I Year
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Semester II

Course: DevOps Methodologies Lab | **Hour** (60 Hours)/**week:** 4 PPW
Course Code: CS202P | **Credits:** 2

Course Objectives: The objectives of this course are,

1. To use version control and Agile tools for collaborative software development.
2. To design and implement CI/CD pipelines using DevOps tools.
3. To deploy and manage applications using containerization and orchestration tools.
4. To automate, test, and monitor systems using IaC and DevOps tools.

LAB EXPERIMENTS:

1. Install Git and GitHub
2. Create Agile board (Jira/Trello)
3. Scrum simulation
4. Kanban board
5. Repository management
6. Branching and merging
7. Docker container setup
8. Docker Compose
9. Kubernetes cluster (Minikube)
10. Jenkins pipeline
11. GitLab CI/CD
12. Ansible configuration
13. Terraform provisioning
14. Selenium/PyTest testing
15. Monitoring using Prometheus & Grafana

NOTE: This course makes exclusive use of open-source DevOps tools and platforms, ensuring accessibility and cost-effectiveness for both academic and professional environments.

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Open-Source Tools Used in This Syllabus:

- **Version Control:** Git (free tier), GitHub (freemium tier), GitLab Community Edition, Bitbucket (freemium tier).
- **Project Management (Agile):** Trello (free tier), Taiga (open-source Agile tool), Jira (freemium tier).
- **CI/CD Pipelines:** Jenkins (free tier), GitLab CI/CD (free tier), CircleCI (freemium tier).
- **Containerization and Orchestration:** Docker (free tier), Docker Compose (free tier), Kubernetes (free tier).
- **Infrastructure as Code (IaC):** Ansible (free tier), Puppet (Community Edition, open source),
  Chef (Community Edition, open source), SaltStack (Community Edition), Terraform (free tier).
- **Testing Frameworks:** Selenium, PyTest, JUnit, Mocha (all open-source testing frameworks).
- **Monitoring and Logging:** Prometheus and Grafana (fully open source), ELK Stack (Elasticsearch, Logstash, Kibana).

Course Outcomes: By the end of the course, the students will be able to,

CS202P.CO1: Apply version control systems and Agile practices for collaborative development.
CS202P.CO2: Develop and implement CI/CD pipelines using modern DevOps tools.
CS202P.CO3: Deploy and manage applications using containerization and orchestration technologies.
CS202P.CO4: Automate testing, provisioning, and monitoring using DevOps and IaC tools.

CO–PO Articulation Matrix

COs / POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CS202P.CO1	2	2	1	3	3	1	1	2	3	2
CS202P.CO2	3	3	1	3	3	1	1	3	2	2
CS202P.CO3	3	3	1	3	2	1	1	3	2	2
CS202P.CO4	3	3	1	3	2	1	1	3	2	3

1 → Low Correlation 2 → Medium Correlation 3 → High Correlation

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Syllabus – M.Sc. (Computer Science) I Year
(w.e.f academic year: 2026-27)
Semester II

Course: Data Science with Python Lab
Course Code: CS203P
Hour (60 Hours)/**week:** 4 PPW
Credits: 2

Course Objectives: The objectives of this course are,

1. To understand fundamentals of Data Science and its link with AI and ML.
2. To develop Python skills for data handling and analysis.
3. To apply statistical and preprocessing techniques for data analysis.
4. To build and evaluate machine learning and basic deep learning models.

Lab Experiments:

Students shall perform the following exercises for any two projects selected from the list of sample projects:

1. Perform dataset inspection using info(), describe(), shape, and columns.
2. Perform data selection and filtering operations using Pandas (row/column selection, conditions).
3. Perform data transformation operations using Pandas (sorting, renaming columns, adding/removing columns).
4. Perform web scraping using BeautifulSoup and Requests to extract data.
5. Compute mean, median, mode, variance, and standard deviation using NumPy/Pandas.
6. Simulate and visualize Normal, Binomial, and Poisson distributions.
7. Perform hypothesis testing: t-test, Chi-Square test, and ANOVA.
8. Perform data cleaning (missing values, duplicates, outliers) and feature scaling.
9. Implement Linear Regression (House Price dataset) and Logistic Regression (Binary Classification).
10. Apply KNN and Decision Tree algorithms on standard datasets.
11. Perform train-test split and k-fold cross-validation.
12. Evaluate models using Accuracy, Precision, Recall, and F1-score.
13. Implement a Multi-Layer Perceptron (MLP) using TensorFlow/Keras.

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14. Implement a simple Feedforward Neural Network for classification using Keras (different dataset).
15. Implement a Convolutional Neural Network (CNN) for image classification (MNIST).
16. Implement a Recurrent Neural Network (RNN) for sequence or time-series prediction.

Case Studies:

Case Study 1: Capstone Project: End-to-End Data Science Project
Case Study 2: Fraud Detection in Financial Transactions Using Machine Learning
Case Study 3: Disease Prediction System Using Data Science Techniques
Case Study 4: Recommendation System for Retail Applications
Case Study 5: Sentiment Analysis on Social Media Data (LAB)

Course Outcomes: By the end of the course, the students will be able to,

CS203P.CO1: Apply Python programming concepts to solve computational problems.
CS203P.CO2: Perform statistical analysis and data pre-processing to extract meaningful insights from datasets.
CS203P.CO3: Design, implement, and evaluate machine learning models for predictive and analytical tasks.
CS203P.CO4: Demonstrate understanding of deep learning models and apply them to solve complex data-driven problems.

CO–PO Articulation Matrix

COs / POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CS203P.CO1	3	2	1	3	1	1	1	1	1	2
CS203P.CO2	3	3	1	3	2	1	1	1	1	2
CS203P.CO3	3	3	1	3	2	1	1	2	1	2
CS203P.CO4	2	2	1	3	2	1	1	2	1	2

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M.Sc. (Computer Science) I Year
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Semester II

Course: R Programming Lab | **Hour** (45 Hrs.)/ **Week:**(2P+1T) PPW
Course Code: CS205P | **Credits:** 2

Course Objectives: The objectives of this course are,

1. To understand and implement basic statistical concepts using R programming.
2. To apply descriptive and inferential statistics techniques for data analysis.
3. To develop skills in data visualization and exploratory data analysis (EDA) for ML.
4. To perform probability distributions, hypothesis testing, and regression analysis practically.

List of Programs:

1. **Basic R Operations:** Write a program to demonstrate variables, data types, operators, and basic input/output in R.
2. **Control Structure in R:** Write a program to demonstrate conditional and looping statements in R.
3. **Data Structures in R:** Write a program to create, delete and manipulate vectors, lists, matrices, and data frames.
4. **Operations on Data Structures in R:** Write a program to sort, filter, merge vectors and data frames.
5. **Importing & Summarizing Data:** Write a program to read data from a CSV file and display summary statistics.
6. **Working with Datasets:** Write a program to upload the default datasets supported by R and perform summary statistics for the same.
7. **Descriptive Statistics:** Write a program to compute mean, median, mode, variance, standard deviation, range, and IQR for a dataset.
8. **Data Visualization:** Write a program to generate histogram, bar chart, boxplot, and scatter plot using base R and ggplot2.
9. **Frequency Distribution:** Write a program to create and interpret frequency tables and cross- tabulations.
10. **Random Sampling:** Write a program to perform random sampling with and without replacement from a dataset.
11. **Probability Distributions:** Write a program to simulate and visualize Normal, Binomial, and Poisson distributions.

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12. **Correlation & Covariance:** Write a program to calculate correlation and covariance matrices and visualize them.
13. **t-Test:** Write a program to perform one-sample, two-sample, and paired t-tests.
14. **Chi-Square Test:** Write a program to perform a Chi-square test for independence.
15. **ANOVA:** Write a program to conduct a one-way ANOVA and interpret the result.
16. **Data Cleaning:** Write a program to handle missing values and detect outliers in a dataset.
17. **Simple Linear Regression:** Write a program to implement simple linear regression and plot the regression line.
18. **Multiple Linear Regression:** Write a program to implement multiple linear regression, display model summary, and calculate R2.
19. **Logistic Regression:** Write a program to classify the data using logistic regression and plot the same.
20. **Exploratory Data Analysis:** Write a program to perform complete EDA (summary, visualization, correlation, outlier detection) on a real-world dataset. (e.g., iris or mtcars).

Course Outcomes: By the end of the course, the students will be able to,

CS205P.CO1: Implement basic R operations and data manipulation techniques.
CS205P.CO2: Perform descriptive and inferential statistical analysis.
CS205P.CO3: Apply regression, correlation, and probability distribution techniques and visualize the same.
CS205P.CO4: Use R for exploratory data analysis and pre-modeling tasks.

Books:

1. Grolemund, Garrett, and Hadley Wickham. *R for Data Science*. O'Reilly Media, 2017.
2. Matloff, Norman. *The Art of R Programming: A Tour of Statistical Software Design*. No Starch Press, 2011.
3. Davies, Tilman M. *The Book of R: A First Course in Programming and Statistics*. 1st edition, No Starch Press, 2016.
4. Kabacoff, Robert I. *R in Action: Data Analysis and Graphics with R*. 2nd edition, Manning Publications, 2015.
5. Bruce, Peter, et al. *Practical Statistics for Data Scientists: 50+ Essential Concepts Using R and Python*. 2nd edition, O'Reilly Media, 2020.
6. Hastie, Trevor, et al. *The Elements of Statistical Learning: Data Mining, Inference, and Prediction*. 2nd edition, Springer, 2017.
7. Verzani, John. *Using R for Introductory Statistics*. Chapman & Hall/CRC, 2014.

CO–PO Articulation Matrix

COs / POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CS205P.CO1	3	2	1	3	2	1	1	1	1	2
CS205P.CO2	3	3	1	3	2	1	1	1	1	2
CS205P.CO3	3	3	1	3	2	1	1	2	1	2
CS205P.CO4	3	3	1	3	2	1	2	2	1	3

1 → Low Correlation 2 → Medium Correlation 3 → High Correlation

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