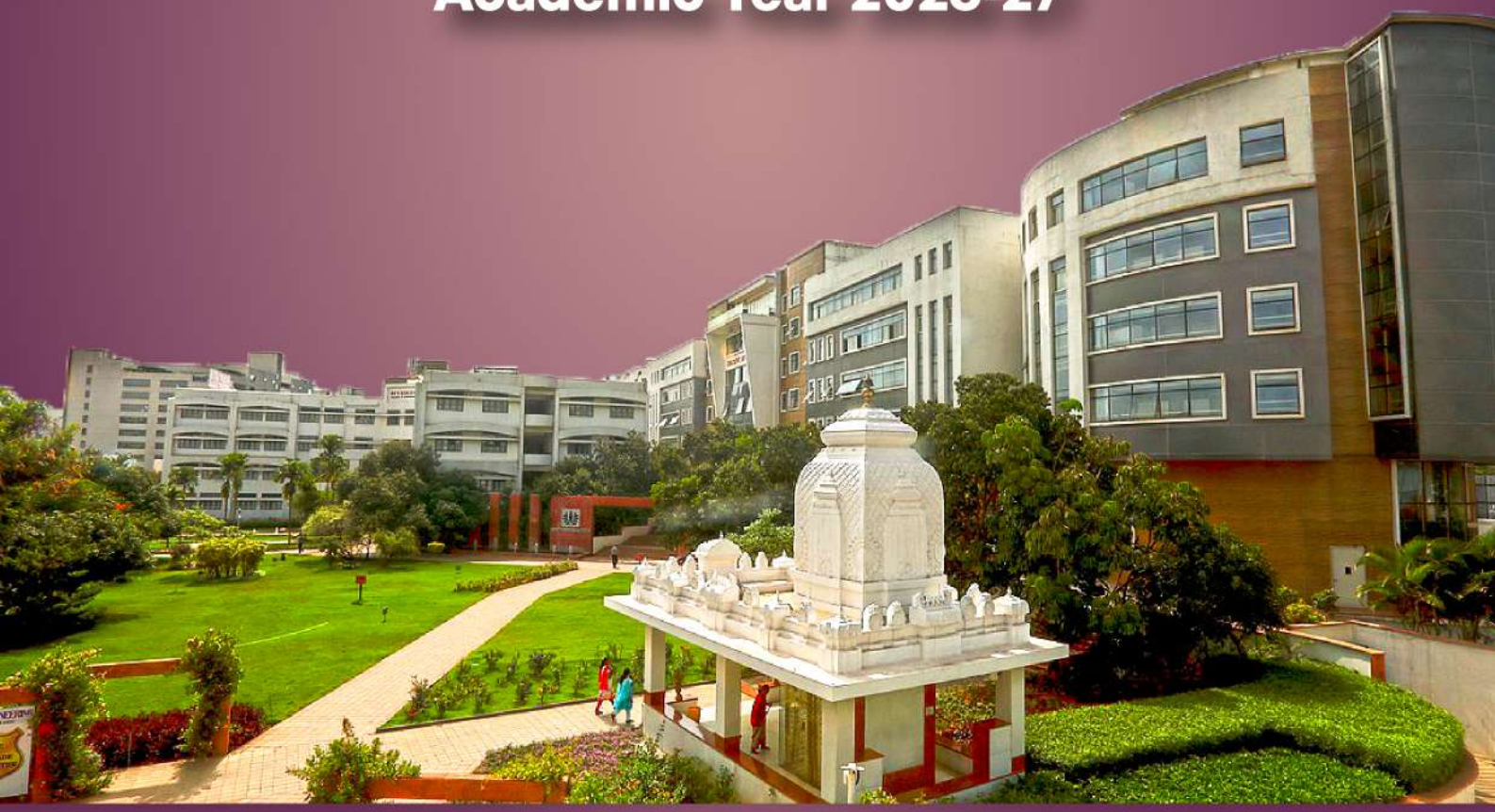
NEW HORIZON COLLEGE OF ENGINEERING

Autonomous College Permanently Affiliated to VTU, Approved by AICTE & UGC
Accredited by NAAC with 'A' Grade, Accredited by NBA

DEPARTMENT OF MASTER OF COMPUTER APPLICATIONS

Scheme 2026
Academic Year 2026-27



MCA

First and Second Semester Scheme & Syllabus
BATCH 2026-28 Onwards
CREDITS:80

Department of Master of Computer Applications

Scheme 2026

Academic Year 2026-27

First and Second Semester
Scheme & Syllabus

Batch: 2026-28

Credits: 80

CONTENTS

1.	Institution Vision, Mission, Quality Policy and Values	1
2.	Department Vision, Mission and Program Educational Objectives (PEO)	2
3.	Program Outcomes (POs) with Graduate Attributes	3
4.	Program Specific Outcomes (PSOs)	3
	SCHEME	
5.	Scheme of First and Second Semester MCA	6
	SYLLABUS	
6.	**Syllabus of First Semester MCA**	
	a) 26MT11- MATHEMATICAL FOUNDATIONS FOR COMPUTER APPLICATIONS	10
	b) 26MC12- DATA STRUCTURES WITH C	12
	c) 26MC13-OBJECT ORIENTED PROGRAMMING WITH JAVA	14
	d) 26MC14-COMPUTER NETWORKS	16
	e) 26MC15-LINUX OPERATING SYSTEM AND SHELL SCRIPTING	18
	f) 26MC16-DATABASE MANAGEMENT SYSTEMS	20
	g) 26MCL17-DATA STRUCTURES LAB	24
	h) 26MCL18-OBJECT ORIENTED PROGRAMMING WITH JAVA LAB	26
	i) 26MC19-PROBLEM SOLVING METHODOLOGIES	28
	j) 26MT110-FOUNDATION MATHEMATICS FOR COMPUTER APPLICATIONS	31
7.	**Syllabus of Second Semester MCA**	
	a) 26MC21 - ADVANCED JAVA	34
	b) 26MC22 - DESIGN AND ANALYSIS OF ALGORITHMS	36
	c) 26MC23- SOFTWARE ENGINEERING AND AGILE DEVELOPMENT	38
	d) 26MCL24 - ADVANCED JAVA LAB	40
	e) 26MCL25 – DEVOPS LAB	42
	f) **CYBER SECURITY SPECIALIZATION**	
	26MCCS26 - CYBER SECURITY AND ETHICAL HACKING	45
	26MCCS27- CRYPTOGRAPHY AND NETWORK SECURITY	47
	26MCCSL28 - ETHICAL HACKING LAB	49
	26MCCSL29 - CRYPTOGRAPHY AND NETWORK SECURITY LAB	52
	g) **DATA SCIENCE SPECIALIZATION**	
	26MCDS26 - ARTIFICIAL INTELLIGENCE AND AGENTIC AI	56
	26MCDS27 - DATA SCIENCE AND VISUALIZATION	59
	26MCDSL28 - AGENTIC AI LAB	62
	26MCDSL29 - DATA SCIENCE AND VISUALIZATION LAB	65

	h) **ENTERPRISE APPLICATION DEVELOPMENT SPECIALIZATION**	
	26MCEA26- ENTERPRISE APPLICATION TESTING AND QUALITY ASSURANCE	69
	26MCEA27- AI FOR ENTERPRISE APPLICATIONS	72
	26MCEAL28- SOFTWARE TESTING AND QUALITY ASSURANCE LAB	74
	26MCEAL29- AI FOR ENTERPRISE APPLICATIONS LAB	78
8.	**Appendices**	
	Appendix A: Outcome Based Education	81
	Appendix B: The Graduate Attributes of NBA	82
	Appendix C: Bloom's Taxonomy	83

NEW HORIZON COLLEGE OF ENGINEERING

VISION

To emerge as an institute of eminence in the fields of engineering, technology and management in serving the industry and the nation by empowering students with a high degree of technical, managerial and practical competence.

MISSION

To strengthen the theoretical, practical and ethical dimensions of the learning process by fostering a culture of research, and innovation among faculty members, and students.

To encourage long-term interaction between the academia and industry through their involvement in the design of curriculum and its hands-on implementation.

To strengthen and mould students in professional, ethical, social and environmental dimensions by encouraging participation in co-curricular and extracurricular activities.

QUALITY POLICY

To provide educational services of the highest quality, both curricular and co-curricular, to enable students to integrate skills and serve the industry and society equally well at the global level.

VALUES

- Academic Freedom
- Integrity
- Inclusiveness
- Innovation
- Professionalism
- Social Responsibility

DEPARTMENT OF

MASTER OF COMPUTER APPLICATIONS

VISION

To emerge as a department of eminence in the field of Computer Applications in serving the Information Technology Industry and the nation by empowering students with a high degree of technical, managerial and practical competence.

MISSION

To strengthen the theoretical, practical and ethical aspects of the learning while inculcating a culture of research, innovation and practical applications amongst faculty and students.

To encourage long-term interactions between the department and the IT Industry through rich involvement of the Industry in the design of the curriculum and its hands-on implementation.

To strengthen and mould students in professional, ethical, social and environmental dimensions by encouraging participation in co-curricular and extracurricular activities.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

PEO1 Excel in the field of Computer Applications and contribute to academia, industry and research.

PEO2 Deliver software solutions that are socially relevant and adapt quickly to emerging technologies.

PEO3 Demonstrate professional behavior by understanding ethical and communication skills to engage in lifelong learning.

PROGRAMME OUTCOMES (POs)

PO1 **(Foundation Knowledge):** Apply knowledge of mathematics, programming logic and coding fundamentals for solution architecture and problem solving.

PO2 **(Problem Analysis):** Identify, review, formulate and analyse problems for primarily focusing on customer requirements using critical thinking frameworks.

PO3 **(Development of Solutions**): Design, develop and investigate problems with an innovative approach for solutions incorporating ESG/SDG goals.

PO4 **(Modern Tool Usage):** Select, adapt and apply modern computational tools such as development of algorithms with an understanding of the limitations including human biases.

PO5 **(Individual and Teamwork):** Function and communicate effectively as an individual or a team leader in diverse and multidisciplinary groups. Use methodologies such as agile.

PO6 **(Project Management and Finance):** Use the principles of project management such as scheduling, work breakdown structure and be conversant with the principles of Finance for profitable project management.

PO7 **(Ethics):** Commit to professional ethics in managing software projects with financial aspects. Learn to use new technologies for cyber security and insulate customers from malware.

PO8 **(Life-long learning):** Change management skills and the ability to learn, keep up with contemporary technologies and ways of working.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO1

Apply knowledge of programming, database systems, operating systems, computer networks, software engineering, and data analytics to analyze, design, and implement computing solutions for real-world applications using modern software tools and technologies.

PSO2

Design and develop innovative, secure, ethical and sustainable software solutions using data science, artificial intelligence, cloud computing, cyber security, and full-stack development to address industry requirements and societal needs.

PEO to Mission Statement Mapping

Mission Statements	PEO1	PEO2	PEO3
To strengthen the theoretical, practical and ethical aspects of the learning while inculcating a culture of research, innovation and practical applications amongst faculty and students.	3	3	2
To encourage long-term interactions between the department and the IT Industry through rich involvement of the Industry in the design of the curriculum and its hands-on implementation.	3	3	2
To strengthen and mould students in professional, ethical, social and environmental dimensions by encouraging participation in co-curricular and extracurricular activities.	2	2	3

Correlation: 3- High, 2-Medium, 1-Low

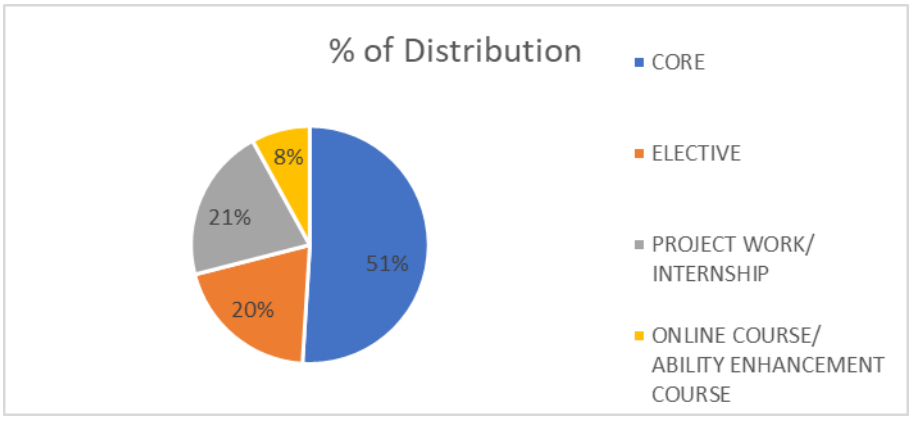
Mapping of POs to PEOs

PO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
PEO1	3	3	3	3	2	2	1	2
PEO2	1	3	3	3	2	2	2	3
PEO3	0	1	1	1	3	2	3	3

DEPARTMENT OF MASTER OF COMPUTER APPLICATIONS
MCA DEGREE CURRICULUM – COURSE CREDIT STRUCTURE
BATCH 2026-28 SEMESTER I TO IV

SEMESTER	CORE	ELECTIVE	PROJECT WORK/ INTERNSHIP	ONLINE COURSE/ ABILITY ENHANCEMENT COURSE	TOTAL CREDITS
I	22	-	-	1*	22
II	11	9	-	1*	20+1*
III	8	7	8	-	23+1*
IV	-	-	9	6	15
TOTAL	41	16	17	6	80+2*
% of Distribution	51	20	21	8	100

*- **Note: Skill Lab Mandatory for award of degree**



DEPARTMENT OF MASTER OF COMPUTER APPLICATIONS
SCHEME OF FIRST SEMESTER MCA PROGRAM
Scheme 2026 - AY 2026-27

SL NO	COURSE	COURSE CODE	COURSE NAME	BOS	CREDIT DISTRIBUTION				OVERALL CREDITS	TLP CONTACT HOURS / SEM	TW & SL / SEM	TOTAL HOURS /SEM	EXAM HRS	MARKS		
					L	T	P	S						CIE	SEE	TOTAL
1	BSC	26MT11	MATHEMATICAL FOUNDATIONS FOR COMPUTER APPLICATIONS	AS	3	0	0	0	3	42	48	90	3	50	50	100
2	PCC	26MC12	DATA STRUCTURES WITH C	MCA	3	0	0	0	3	42	48	90	3	50	50	100
3	PCC	26MC13	OBJECT ORIENTED PROGRAMMING WITH JAVA	MCA	3	0	0	0	3	42	48	90	3	50	50	100
4	PCC	26MC14	COMPUTER NETWORKS	MCA	3	0	0	0	3	42	48	90	3	50	50	100
5	PCC	26MC15	LINUX OPERATING SYSTEM AND SHELL SCRIPTING	MCA	3	0	0	0	3	42	48	90	3	50	50	100
6	IPCC	26MC16	DATABASE MANAGEMENT SYSTEMS	MCA	3	0	1	0	4	70	50	120	3	50	50	100
7	PCCL	26MCL17	DATA STRUCTURES LAB	MCA	0	0	1.5	0	1.5	42	3	45	3	50	50	100
8	PCCL	26MCL18	OBJECT ORIENTED PROGRAMMING WITH JAVA LAB	MCA	0	0	1.5	0	1.5	42	3	45	3	50	50	100
9	AEC	26MC19	PROBLEM SOLVING METHODOLOGIES	MCA	0	0	0	0	-	28	32	60	-	50	-	PP
10	NCMC	26MT110	FOUNDATION MATHEMATICS FOR COMPUTER APPLICATIONS #	AS	-	-	-	-	-	42	48	90	-	50	-	50
			TOTAL		18	0	4	0	22	434	376	810	24	500	400	850

Note: **BSC -** Basic Science Course, **PCC** - Professional Core Course, **AEC -** Ability Enhancement Course
IPCC - Integrated Professional Core Course, (No SEE for lab component, only CIE), **PCCL** - Professional Core Course Lab
CI - Classroom Instruction, **LI -** Laboratory Instruction**, L** - Lecture, **T** - Tutorial, **P** - Practical, **TW & SL -** Term work & Self Learning

Research Methodology and IPR & Credited Online Courses should be mandatorily taken by the students anytime during the program, However, the marks will be included in 4th semester. Students have to qualify for the award of master's degree

#**Bridge Course:** Non-Credit Mandatory Course 26MT110 - Foundation Mathematics for Computer Applications - Students who have not taken Mathematics at the 10+2 or degree level are required to study and pass this course in the 1st semester.
However, this course will not be considered for vertical progression.

DEPARTMENT OF MASTER OF COMPUTER APPLICATIONS
SCHEME OF SECOND SEMESTER MCA PROGRAM
Scheme 2026 - AY 2026-27

SL NO	COURSE	COURSE CODE			BOS	CREDIT DISTRIBUTION				OVERALL CREDITS	TLP CONTACT HOURS / SEM	TW & SL / SEM	TOTAL HOURS /SEM	EXAM HRS	MARKS		
		CYBER SECURITY	DATA SCIENCE	ENTERPRISE APPLICATION DEVELOPMENT		L	T	P	S						CIE	SEE	TOTAL
1	PCC	26MC21	26MC21	26MC21	MCA	3	0	0	0	3	42	48	90	3	50	50	100
2	PCC	26MC22	26MC22	26MC22	MCA	3	0	0	0	3	42	48	90	3	50	50	100
3	PCC	26MC23	26MC23	26MC23	MCA	3	0	0	0	3	42	48	90	3	50	50	100
4	PCCL	26MCL24	26MCL24	26MCL24	MCA	0	0	1	0	1	28	2	30	3	50	50	100
5	PCCL	26MCL25	26MCL25	26MCL25	MCA	0	0	1	0	1	28	2	30	2	50	50	100
6	PEC	26MCCS26	26MCDS26	26MCEA26	MCA	3	0	0	0	3	42	48	90	3	50	50	100
7	PEC	26MCCS27	26MCDS27	26MCEA27	MCA	3	0	0	0	3	42	48	90	3	50	50	100
8	PECL	26MCCSL28	26MCDSL28	26MCEAL28	MCA	0	0	1.5	0	1.5	42	3	45	3	50	50	100
9	PECL	26MCCSL29	26MCDSL29	26MCEAL29	MCA	0	0	1.5	0	1.5	42	3	45	3	50	50	100
TOTAL						15	0	5	0	20	350	250	600	26	450	450	900
SKILL LAB * (MANDATORY FOR THE AWARD OF THE DEGREE; REFLECTS IN FINAL SEMESTER GRADE CARD)																	
1	AEC	26MCSL20	SKILL LAB - I		MCA	0	0	1	0	1	-	30	30	-	50	-	50

Note: **PCC** - Professional Core Course, **PCCL** - Professional Core Course Lab, **AEC -** Ability Enhancement Course, **PEC –** Professional Elective Course, **PECL -** Professional Elective Course Lab **CI** - Classroom Instruction, **LI** - Laboratory Instruction**, L** - Lecture, **T** - Tutorial, **P** - Practical, **TW & SL -** Term work & Self Learning

NOTE: *As per VTU Circular No. VTU/BGM/Skill lab/1016/2026-27/1736, dated 15 July 2026.

SECOND SEMESTER Core Courses	
Course Code	**Course Name**
26MC21	ADVANCED JAVA
26MC22	DESIGN AND ANALYSIS OF ALGORITHMS
26MC23	SOFTWARE ENGINEERING AND AGILE DEVELOPMENT
26MCL24	ADVANCED JAVA LAB
26MCL25	DEVOPS LAB

CYBER SECURITY SPECIALIZATION		**DATA SCIENCE SPECIALIZATION**		**ENTERPRISE APPLICATION DEVELOPMENT SPECIALIZATION**	
Course Code	**Course Name**	**Course Code**	**Course Name**	**Course Code**	**Course Name**
26MCCS26	CYBER SECURITY AND ETHICAL HACKING	26MCDS26	ARTIFICIAL INTELLIGENCE AND AGENTIC AI	26MCEA26	ENTERPRISE APPLICATION TESTING AND QUALITY ASSURANCE
26MCCS27	CRYPTOGRAPHY AND NETWORK SECURITY	26MCDS27	DATA SCIENCE AND VISUALIZATION	26MCEA27	AI FOR ENTERPRISE APPLICATIONS
26MCCSL28	ETHICAL HACKING LAB	26MCDSL28	AGENTIC AI LAB	26MCEAL28	SOFTWARE TESTING AND QUALITY ASSURANCE LAB
26MCCSL29	CRYPTOGRAPHY AND NETWORK SECURITY LAB	26MCDSL29	DATA SCIENCE AND VISUALIZATION LAB	26MCEAL29	AI FOR ENTERPRISE APPLICATIONS LAB

FIRST SEMESTER

MCA SYLLABUS

(2026-27)

MATHEMATICAL FOUNDATIONS FOR COMPUTER APPLICATIONS			
Course Code	**26MT11**	**Credits**	**03**
L:T:P:S	**3:0:0:0**	**CIE Marks**	**50**
TLP Contact Hours / Sem	**28+28**	**SEE Marks**	**50**
TW & SL / Sem	**34**	**Total Marks**	**100**
Total Hours /Sem	**90**	**Exam Hours**	**03**

Course outcomes:
At the end of the course, the student will be able to:

26MATC11.1	Understand the concepts of differentiation, integration and linear algebra in solving the problems of computational applications.
26MATC11.2	Apply numerical techniques to solve real time problems involving non-algebraic equations and integration concepts.
26MATC11.3	Analyze function composition, inverse functions, and apply the Pigeonhole Principle to solve counting and existence problems in engineering.
26MATC11.4	Apply propositional logic to construct truth tables and analyze the validity of logical statements using logical connectives.
26MATC11.5	Apply graph concepts to model and represent relationships and networks in computer science and real-world applications

MODULE-1	**MATHEMATICAL FOUNDATIONS**	**26MATC11.1**	**8 Hours**
Differentiation- Product Rule, Quotient Rule, Chain Rule and Applications of Finding Velocity and Acceleration. Integration- Definite & Indefinite Integration and Integration by Parts. Matrices- Determinant and Inverse of a Matrix, Eigen Values and Eigen Vectors of a Square Matrix.			
Self-study	Rank of a matrix. Diagonalization of a matrix.		
Text Book	Text Book 1: 34.4, 34.5, 34.6, 34.7, 34.8, 34.9, 35.1, 35.2, 35.3, 35.4		
MODULE-2	**NUMERICAL ALGORITHMS**	**26MATC11.2**	**8 Hours**
Roots of Algebraic and Non-Algebraic Equations- Newton-Raphson Iteration Method. Numerical Integration- Trapezoidal Rule, Simpson's $1/3^{rd}$ rule and Simpson's $3/8^{th}$ rule. Solution of System of Linear Equations-Gauss Seidel Iteration Method.			
Self-study	Numerical solution of algebraic and non-algebraic equations by bisection method,		
Text Book	Text Book 2: 28.1, 28.2, 28.7, 30.4, 30.5, 30.6, 30.7, 30.8		
MODULE-3	**RELATIONS AND FUNCTIONS**	**26MATC11.3**	**8 Hours**
Cartesian Products and Relations, Properties of Relations, Equivalence Relations and Partitions. Partial orders, Hasse diagram One-to-One and onto functions, composite and inverse functions. The Pigeon hole principle,			
Self-study	Introduction and operations on set theory.		
Text Book	Text Book 3: 5.1, 5.2, 5.3, 5.5, 5.6, 7.1, 7.3, 7.4.		
MODULE-4	**MATHEMATICAL LOGIC**	**26MATC11.4**	**9 Hours**
Basic Connectives and Truth Tables, Tautology and Contradiction, Logic Equivalence, The Laws of Logic, Converse, Inverse and Contra positive, Logical Implication, Rules of Inference, Introduction to quantifiers.			
Self-study	NAND, NOR connectives problems		
Text Book	Text Book 3: 2.1, 2.2, 2.3. 2.4, 2.5.		
MODULE-5	**GRAPH THEORY**	**26MATC11.5**	**9 Hours**
Introduction, Basic definition, Application of graphs, finite, infinite and bipartite graphs, incidence and degree, isolated vertex, pendant vertex and null graph. Isomorphism of graphs. Introduction to sub-graphs, walks, paths, circuits and cycles.			
Self-study	Graph coloring, chromatic polynomials.		
Text Book	Text Book 3: 11.1, 11.2, 11.3, 11.4		

CIE Assessment Pattern (50 Marks – Theory)

RBT Levels		Marks Distribution		
		Test (s)	AAT1	AAT2
		25	15	10
L1	Remember	-	-	-
L2	Understand	5	-	-
L3	Apply	10	5	5
L4	Analyze	10	5	5
L5	Evaluate	-	5	-
L6	Create			-

SEE Assessment Pattern (50 Marks – Theory)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	-
L2	Understand	10
L3	Apply	20
L4	Analyze	20
L5	Evaluate	-
L6	Create	-

Suggested Learning Resources:

Text Books:

1) John Birs, Basic Engineering Mathematics, 6th Edition, 2014, Routledge Taylor & Francis Group, ISBN: 9780415662789
2) B. S. Grewal, Higher Engineering Mathematics, Khanna Publishers, Forty fourth Edition, 2022, ISBN: 9788193328491.
3) Ralph P. Grimaldi, Discrete and Combinatorial Mathematics-an applied introduction, Pearson Education, Fifth Edition, 2019, ISBN: 9789353433055.

Reference Books:

1) Basavaraj S. Anami and Venkanna S. Madalli, Discrete Mathematics – A Concept based approach, Universities Press, 2016, ISBN: 9788173719998
2) Kenneth H. Rosen, Discrete Mathematics and its Applications with Combinatorics and Graph Theory, McGraw Hill Education**,** Seventh Edition, 2017, ISBN: 9780070681880
3) D.S. Malik and M.K. Sen, Discrete Mathematical Structures: Theory and Applications, Thomson, 2004. ISBN: 9780619212858
4) Thomas Koshy, Discrete Mathematics with Applications, Elsevier, First Edition 2005, ISBN: 9788181478870.

Web links and Video Lectures (e-Resources):

- https://youtu.be/O4Qf0SQKkZw?si=1r9joVe2-rP04fCH
- https://youtu.be/Hbyj6vEi7fY?si=_GaCjUHBNdV2MArP
- https://youtu.be/7hLvm_4DNqs?si=viYHH_fZDZQ9Fmdw
- https://youtu.be/7hLvm_4DNqs?si=viYHH_fZDZQ9Fmdw
- https://youtu.be/6Z_eengdMVE?si=-ZlPy2xl18oMUwfR
- https://youtu.be/fwSiTaCs8KM?si=wpZcCEG-pNDuIPkS
- https://youtu.be/iHC1ZdLdKjw?si=tuN-6pLqhMWPN4Mb
- https://youtu.be/auvGQCoYdu4?si=3ELSyG5g-475AN1_
- https://youtu.be/GLHWih_RB38?si=FuoNQAzNR2llYpU0

Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning

- Problem solving Approach
- Organizing Group wise discussions on related topics
- Seminars

***

DATA STRUCTURES WITH C			
Course Code	**26MC12**	**Credits**	**03**
L:T:P:S	**3:0:0:0**	**CIE Marks**	**50**
TLP Contact Hours / Sem	**42**	**SEE Marks**	**50**
TW & SL / Sem	**48**	**Total Marks**	**100**
Total Hours /Sem	**90**	**Exam Hours**	**03**

Course outcomes:
At the end of the course, the student will be able to:

26MC12.1	Explain fundamental concepts of data structures and implement arrays, searching and sorting techniques using C.
26MC12.2	Apply stacks and recursion in problem solving using C.
26MC12.3	Use operations of queues and priority queues in computing applications.
26MC12.4	Analyze and implement different types of linked lists using pointers and dynamic memory allocation.
26MC12.5	Analyze and implement trees, heaps, hashing and graph representations and traversals using C.

MODULE-1	**INTRODUCTION TO DATA STRUCTURES, SORTING AND SEARCHING TECHNIQUES**	**26MC12.1**	**8 Hours**

Data Structures – Definition, Need, Classification and Applications. C Foundations for Data Structures – data types, structures and typedef, pointers and pointer arithmetic, pointers with arrays and structures. Static Memory Allocation and basic operations. Arrays – one-dimensional and two-dimensional arrays, representation and memory organization, insertion, deletion, traversal, merging and array-based applications. Sorting Algorithms – Selection Sort, Bubble Sort. Searching Techniques – Linear Search and Binary Search.

Applications	Applications of arrays in data representation and processing; comparison of basic sorting and searching techniques.
Text Book	Text Book 1: Chapters 1, 2 and 11, Text Book 2: Chapters 1, 2, 3, 4 and 12.

MODULE-2	**STACKS AND RECURSION**	**26MC12.2**	**8 Hours**

Array Representation of Stack, Operations on a Stack, static and dynamic implementation, overflow and underflow. Applications of Stacks – Processing of Function Calls, reversing a String, Checking Correctness of Well-Formed Parentheses, Conversion from Infix to Postfix and Evaluation of a Postfix Expression. Recursion – Recursive Definition and Processes, Designing Recursive Functions, Recursion versus Iteration, Factorial of a Number, Fibonacci Numbers and Towers of Hanoi Problem.

Case Study	Case studies for demonstrating the use of stacks in recursive applications.
Text Book	Text Book 1: Chapters 3, 4 and 8, Text Book 2: Chapters 6 and 8.

MODULE-3	**QUEUES AND DYNAMIC MEMORY ALLOCATION**	**26MC12.3**	**8 Hours**

Array Representation of Queues, Comparing Queues with Stacks, Primitive Operations of Queue with Implementation. Other Types of Queues with Operations – Circular Queues, Double Ended Queues and Priority Queues. Priority Queues – Min-Heap and Max-Heap, Applications of Priority Queues – Job Scheduling. Dynamic Memory Allocation – malloc(), calloc(), realloc() and free(), static versus dynamic memory allocation and applications of dynamic memory.

Case Study	Case studies for demonstrating the use of queues in real time applications.
Text Book	Text Book 1: Chapter 5, Text Book 2: Chapter 9.

MODULE-4	**LINKED LISTS**	**26MC12.4**	**9 Hours**

Arrays versus Linked Lists. Types of Lists – Singly Linked List, Circular Singly Linked List, Doubly Linked List and Circular Doubly Linked List. Operations on Lists – Creation, Insertion, Deletion, Traversal, Searching, Updating and Reversal. Stack and Queue Implementation using Lists. Applications of Lists and Polynomial Representation.

Applications	Comparison of array and linked representations; applications of linked lists in dynamic data organization.
Text Book	Text Book 1: Chapter 6, Text Book 2: Chapter 7.

MODULE-5	**TREES, HEAPS, HASHING AND GRAPHS**	**26MC12.5**	**9 Hours**

Introduction, Applications and Importance of Trees, Basic Tree Concepts and Terminologies, Binary Trees, Complete Binary Trees, Binary Search Trees, Tree Traversals – In-order, Pre-order and Post-order, AVL Trees

and Heaps. Heap Operations and Applications. Hashing – Hash Tables, Hash Functions and Collision Resolution Techniques. Basic Terminologies in Graphs, Graph Representations – Adjacency Matrix and Adjacency Lists, Traversals of Graphs – Breadth First Search (BFS) and Depth First Search (DFS).

Case Study	Case studies on hierarchical data using trees, priority-based processing using heaps, dictionary implementation using hashing, and graph traversal.
Text Book	Text Book 1: Chapters 9, 10 and 12, Text Book 2: Chapters 10, 11 and 12.

CIE Assessment Pattern (50 Marks – Theory)

RBT Levels		Marks Distribution		
		Test (s)	AAT1	AAT2
		25	15	10
L1	Remember	-	-	-
L2	Understand	5	3	2
L3	Apply	10	6	4
L4	Analyze	10	6	4
L5	Evaluate	-	-	-
L6	Create	-	-	-

SEE Assessment Pattern (50 Marks – Theory)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	-
L2	Understand	10
L3	Apply	20
L4	Analyze	20
L5	Evaluate	-
L6	Create	-

Suggested Learning Resources:

Text Books:

1) Ashok N. Kamthane, Data Structures Using C, Pearson India, May 2024, ISBN: 9781299444805.
2) E. Balagurusamy, Data Structures Using C, 2nd Edition, McGraw Hill Education, 2025, ISBN: 9789364443012.

Reference Books:

1) Reema Thareja, Data Structures Using C, 3rd Edition, Oxford University Press, 2023, ISBN: 9789354977190.
2) Yedidyah Langsam, Moshe J. Augenstein and Aaron M. Tenenbaum, Data Structures Using C and C++, Pearson Education India, 2nd Edition, 2015, ISBN: 9789332549319.

Web links and Video Lectures (e-Resources)

- https://www.coursera.org/learn/data-structures
- https://nptel.ac.in/courses/106106127
- https://nptel.ac.in/courses/106102064

Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning

- Demonstration of sorting algorithms
- Demonstration of recursive algorithms
- Case studies for queue applications
- Case studies on graph traversals

****

OBJECT ORIENTED PROGRAMMING WITH JAVA			
Course Code	**26MC13**	**Credits**	**03**
L:T:P:S	**3:0:0:0**	**CIE Marks**	**50**
TLP Contact Hours / Sem	**42**	**SEE Marks**	**50**
TW & SL / Sem	**48**	**Total Marks**	**100**
Total Hours /Sem	**90**	**Exam Hours**	**03**

Course outcomes:
At the end of the course, the student will be able to:

26MC13.1	Discuss the fundamentals of Object-Oriented programming and the Java Execution Environment.
26MC13.2	Summarize the usage and application of String Handling and Object-Oriented Techniques.
26MC13.3	Illustrate the principles of Inheritance, Packages and Interface implementation.
26MC13.4	Analyze Exception Handling mechanisms and Multithreading in Java.
26MC13.5	Examine Java Generics, Collection Interfaces and AWT components for File Handling and GUI development.

MODULE-1	**OVERVIEW OF JAVA**	**26MC13.1**	**8 Hours**

Introduction, Object-Oriented Programming Concepts, JDK, JRE, JVM, Program Structure. Data Types, Variables, Scope Of Variables, Operators, Expression, Keywords, Identifiers, Class Libraries, Primitive Types, Wrapper Classes, Literals, Type Conversion, Input and Output Statements, Decision Making, Branching, Loop Control Statements, Enumeration, Class Fundamentals, Objects, Methods, Constructors, This Keyword, Garbage Collection, Finalize( ) Method.

Self-Study	Study the use of comments and documentation in Java programs. Explore escape sequences and their use in displaying formatted output.
Text Book	Text Book 1: Chapter 1, 2, 3, 4, 5, 6, 19, Text Book 2: Chapter 22

MODULE-2	**ARRAYS AND STRING HANDLING**	**26MC13.2**	**8 Hours**

Arrays- Fundamentals, Types, Passing Array to a Method, Array of Objects.
String Constructors, Methods, String Buffer, String Builder, String Tokenizer, Overloading Methods, Objects as Parameters, Argument Passing, Returning Objects, Recursion, Access Control, Static, Final, Nested Classes, VarArgs.

Case Study	To develop a system to store student details and marks using arrays and objects, process results using methods, and demonstrate string handling, method overloading, recursion, static, final, and VarArgs concepts.
Text Book	Text Book 1: Chapter 7, 18

MODULE-3	**INHERITANCE**	**26MC13.3**	**8 Hours**

Basics, Types, Super, Visibility Control, Method Overriding, Dynamic Method Dispatch, Abstract Classes, Interfaces – Extending Multiple Interfaces, Implementing Interfaces, Nested Interfaces, Marker Interfaces, Packages -Fundamentals, Types, Accessing Packages, Importing Packages.

Applications	Create an Interactive Application which demonstrates the different types of Inheritance.
Text Book	Text Book 1: Chapter 8, 9

MODULE-4	**EXCEPTION HANDLING AND MULTITHREADING**	**26MC13.4**	**9 Hours**

Fundamentals, Exception Types, Try-Catch-Finally, Multiple Catch Clauses, Nested Try Statements, Throw, Throws, Built-In Exceptions, Custom Exceptions. Multithreaded Programming – Fundamentals, The Java Thread Model, Lifecycle, Thread Priorities, Thread Creation using Extends, using Implements Keyword, Creating Multiple Threads, Thread Methods, Synchronization - Synchronization Methods, Synchronized Statement, Thread Communication - notify(), wait() and notifyAll().

Applications	• Create an interactive Multithreading application using methods of Thread class. • Develop an interactive application which uses User-Defined Exceptions.
Text Book	Text Book 1: Chapter 10, 11

MODULE-5	**GENERICS, COLLECTIONS, AWT AND I/O OPERATIONS**	**26MC13.5**	**9 Hours**

Generics – Advantages, Generic Methods, Generic Constructors, Generic Classes. Collection Interfaces. Java

AWT - Components, Layouts, Event Handling, Listeners, IO Stream Classes, File Handling.	
Applications	Develop a simple desktop application to manage books and members using Generics, Collections, AWT components, layouts, event handling, and file handling for storing and retrieving records.
Text Book	Text Book 1: Chapter 13, 14, 20, 22 Text Book 2: Chapter 23, 24, 27, 29

CIE Assessment Pattern (50 Marks – Theory)

RBT Levels		Marks Distribution		
		Test (s)	AAT1	AAT2
		25	15	10
L1	Remember	-	-	-
L2	Understand	5	3	2
L3	Apply	10	6	4
L4	Analyze	10	6	4
L5	Evaluate	-	-	-
L6	Create	-	-	-

SEE Assessment Pattern (50 Marks – Theory)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	-
L2	Understand	10
L3	Apply	20
L4	Analyze	20
L5	Evaluate	-
L6	Create	-

Suggested Learning Resources:

Text Books:

1) Herbert Schildt, *Java: The Complete Reference*, Tata McGraw Hill, 13th Edition, 2024, ISBN: 978-1-265-05843-2.
2) R. Nageswara Rao, *Core Java: An Integrated Approach: Includes All Versions up to Java 8*, Dreamtech Press, 1st Edition, 2016, ISBN: 978-93-5119-925-0.

Reference Books:

1) Cay S. Horstmann, *Core Java Volume I – Fundamentals*, Prentice Hall, 11th Edition, 2018, ISBN: 978-0-13-516630-7.
2) Kathy Sierra and Bert Bates, *Head First Java*, O'Reilly Publications, 3rd Edition, 2022, ISBN: 978-93-5542-090-9.

Web links and Video Lectures (e-Resources):

- https://www.javatpoint.com/inheritance-in-java
- https://archive.nptel.ac.in/courses/106/105/106105191/
- https://java-iitd.vlabs.ac.in/
- https://www.tutorialspoint.com/java/java_multithreading.htm
- https://www.w3schools.com/java/java_try_catch.asp
- https://www.programiz.com/java-programming/collections

Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning:

- Video demonstration of latest technologies in Java.
- Case study on real world problems
- Expert talk & Seminars

****

COMPUTER NETWORKS			
Course Code	**26MC14**	**Credits**	**03**
L:T:P:S	**3:0:0:0**	**CIE Marks**	**50**
TLP Contact Hours / Sem	**42**	**SEE Marks**	**50**
TW & SL / Sem	**48**	**Total Marks**	**100**
Total Hours /Sem	**90**	**Exam Hours**	**03**

Course outcomes:
At the end of the course, the student will be able to:

26MC14.1	Explain the basic concepts of networks and reference models.
26MC14.2	Use protocols and algorithms to setup and troubleshooting networks.
26MC14.3	Analyze network traffic to identify bottlenecks or security vulnerabilities.
26MC14.4	Summarize the functions and mechanisms of transport layer protocol.
26MC14.5	Interpret the data exchanged in application layer protocol to understand their behavior and performance.

MODULE-1	**INTRODUCTION TO COMPUTER NETWORKS**	**26MC14.1**	**8 Hours**

Introduction, Applications, Requirements, Connectivity, Network Topology, Modes, Scale. Network Protocol Stack (TCP/IP and ISO-OSI), Physical Layer - Guided and Unguided Transmission Media, Digital Modulation Techniques (NRZ, NRZI, Manchester,4B/5B), Multiplexing (FDMA, TDMA, CDMA), Performance, Mobile Telephone Systems (1G, 2G,3G, 4G).

Case Study	A case study on computer networking and its network configuration
Text Book	Text Book 1: Chapter 1, 2 Text Book 2: Chapter 1.1, 1.2, 1.3

MODULE-2	**DATA LINK LAYER**	**26MC14.2**	**8 Hours**

Design Issues, Services to Network Layer, Framing, Error Detection and Correction Codes, Data Link Protocols for Noiseless Channels – Simplex, Stop-and-wait, Noisy Channels – Stop-and-wait ARQ, Go-back-N ARQ, Selective Repeat ARQ. Medium Access Sub-layer -Multiple Access Protocols and Examples: ALOHA, Pure ALOHA, Slotted ALOHA Protocol, Ethernet – 802.3 Frame Format, Carrier Sense Multiple Access (CSMA), Frame format of CSMA, Types of CSMA, CSMA with Collision Detection (CSMA/CD).

Case Study	A case study on network security issues of data link layer
Text Book	Text Book 1: Chapter 3, 4 Text Book 2: Chapter 2.2, 2.4, 2.5, 2.6

MODULE-3	**NETWORK LAYER**	**26MC14.3**	**8 Hours**

Functions, Design Issues, Routing Algorithms- Dijkstra Algorithm, Distance Vector Algorithm, Flooding, Multicasting Routing, Congestion Control Algorithms - Leaky Bucket, Token Bucket, Cause of Congestion, Congestion Control Methods - Open-Loop Congestion Control, Closed-Loop Congestion. Congestion Avoidance Mechanisms, Quality of Service, Internetworking – Tunneling Internetwork routing, Fragmentation, IPV4 and IPV6, ARP, ICMP.

Applications	To Simulate Distance Vector routing for a small network topology.
Text Book	Text Book 1: Chapter 5, Text Book 2: Chapter 3

MODULE-4	**TRANSPORT LAYER**	**26MC14.4**	**9 Hours**

Transport Layer Services, Elements of Transport Protocols, Connection Establishment - Two-Way Handshake, Connection and Release, Three-way Handshake, Protocols- UDP, TCP, Performance Issues.

Case Study	Analyze the use of TCP and UDP in video conferencing applications, comparing connection establishment, reliability, delay, and performance
Text Book	Text Book 1: Chapter 6, Text Book 2: Chapter 4.1.3, 4.4.2

MODULE-5	**APPLICATION LAYER**	**26MC14.5**	**9 Hours**

Design Issues, DNS - Structure, Message Format. Examples: Email-SMTP, POP3, IMAP, World Wide Web - Architecture, Working, Streaming Audio and Video and Content Delivery, FTP, TELNET.

Self-Study	Introduction to Internet applications, web browsers, search engines, cloud services, and basic Internet security.

Text Book	Text Book 1: Chapter 7, Text Book 2: Chapter 9

CIE Assessment Pattern (50 Marks – Theory)

RBT Levels		Marks Distribution		
		Test (s)	AAT1	AAT2
		25	15	10
L1	Remember	-	-	-
L2	Understand	5	4	3
L3	Apply	10	5	3
L4	Analyze	10	6	4
L5	Evaluate	-	-	-
L6	Create	-	-	-

SEE Assessment Pattern (50 Marks – Theory)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	-
L2	Understand	10
L3	Apply	20
L4	Analyze	20
L5	Evaluate	-
L6	Create	-

Suggested Learning Resources:

Text Books:

1) Andrew S. Tanenbaum, Nick Feamster, and David J. Wetherall, *Computer Networks*, Pearson, 6th Edition, 2022, ISBN: 978-0-13-752321-4.
2) Larry L. Peterson and Bruce S. Davie, *Computer Networks: A Systems Approach*, Morgan Kaufmann, 6th Edition, 2021, ISBN: 978-0-12-818200-0.

Reference Books:

1) N. Olifer and V. Olifer, *Computer Networks: Principles, Technologies and Protocols for Network Design*, Wiley, 2005, ISBN: 978-0-470-86982-6.
2) James F. Kurose and Keith W. Ross, *Computer Networking: A Top-Down Approach*, Pearson Education, 8th Edition, 2022, ISBN: 978-0-13-592861-5.

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/106/105/106105183/
- https://onlinecourses.swayam2.ac.in/cec23_cs07/preview

Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning:

- Video demonstration of latest technology in computer networks.
- Contents related activities (Activity-based discussions)
  - Students to write and execute networks related programs & group wise discussions.

****

LINUX OPERATING SYSTEM AND SHELL SCRIPTING			
Course Code	**26MC15**	**Credits**	**03**
L:T:P:S	**3:0:0:0**	**CIE Marks**	**50**
TLP Contact Hours / Sem	**42**	**SEE Marks**	**50**
TW & SL / Sem	**48**	**Total Marks**	**100**
Total Hours /Sem	**90**	**Exam Hours**	**03**

Course outcomes:
At the end of the course, the student will be able to:

26MC15.1	Explain the architecture, components, and services of operating systems, and their role in process, memory, and file management.
26MC15.2	Apply Linux commands to manage files, directories, user permissions, ownership, and links in a multiuser environment.
26MC15.3	Apply shell scripting constructs such as variables, command-line arguments, control structures, and functions to automate Linux system tasks.
26MC15.4	Analyze the use of regular expressions, filters, and AWK programming constructs for text processing and data manipulation in Linux environments.
26MC15.5	Analyze memory management and disk scheduling techniques used in operating systems.

MODULE-1	**INTRODUCTION TO OPERATING SYSTEM**	**26MC15.1**	**8 Hours**

Introduction, System Components, Open-Source Operating Systems, Operating System Services, System Calls, Process Management- Process Structure, Process states, Types of Schedulers, Scheduling Criteria, Scheduling algorithms. Deadlock and Starvation- Principles of Deadlock, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection and Recovery.

Self-study	Draw the process-state transition diagram and solve CPU-scheduling problems using FCFS, SJF and Round Robin; calculate waiting time and turnaround time.
Text Book	Text Book 1: Chapter 1, 2, 3, 5 and 8 Text Book 2: Chapter 1, 5 and 6

MODULE-2	**FILE MANAGEMENT IN LINUX**	**26MC15.2**	**8 Hours**

Linux Environment, Fundamental Commands. System Shell and User Shells. Linux System Architecture, Users in Linux Multiuser System, HOME Directory, File System Structure, File Naming Conventions, Relative Path and Absolute Path, File Management Commands - cd, mkdir, cp, mv, rm, rmdir, cat, File Attributes - ls, ls -l, ls -d, File Permissions, Directory Permissions, File Ownership, Changing Ownership and Group using chmod, umask, chown & chgrp, Changing File Modification and Access Times using touch, Hard Link, Symbolic Link, find command.

Self-study	Explore Linux file-system structure, paths, file attributes, links, and the find command.
Text Book	Text Book 2: Chapter 1, 2, 4 and 7

MODULE-3	**SHELL PROGRAMMING**	**26MC15.3**	**8 Hours**

Introduction, Shell Variables, Shell Scripts, Reading Values, Positional Parameters, Command Line Arguments, exit Status of a Command, Logical Operators, Control Structures, Test Conditions, Evaluating Values, sleep, wait. Shell Programming- Assigning Values to Positional Parameters using set, shift, Output Redirection, Input Redirection, Shell Functions. Process Management Commands in Linux - ps, Running Jobs in Background, Introduction to Commands like nice, at and batch, and cron.

Application	Develop a shell script to implement a terminal-locking mechanism that securely accepts and verifies a password, locks the terminal after successful confirmation, and unlocks it only when the correct password is entered, using Linux commands and shell programming constructs.
Text Book	Text Book 2: Chapters 2, 7, 8, 11 Text Book 3: 1, 2, 3, 4, 5, 6, 7

MODULE-4	**SIMPLE FILTERS**	**26MC15.4**	**9 Hours**

Definition, Usage of filters – tr, cut, paste, grep, wc, head, tail, sort, more. Usage of Regular Expressions with grep and sed (stream editor), Advanced Filters- Simple awk Filtering, BEGIN and END sections, built-in variables, arrays, functions, control flow, looping, Develop Utilities using Filters.

Application	Write an awk script to find the total number of books sold in each discipline as well as the total number of books sold, using an associative array. For example: Electrical 34, Mechanical 67, Electrical 80, Computer Science 43, Mechanical 65, Civil 98, Computer Science 64.
Text Book	Text Book 4: Chapters 1, 2, 3, 4, 6, 7, 8, 9, 10 and 11

MODULE-5	**LINUX MEMORY MANAGEMENT**	**26MC15.5**	**9 Hours**

Memory Types, Contiguous Memory Allocation, Algorithms – First Fit, Best Fit and Worst Fit, Internal Fragmentation, Non-Contiguous Memory Allocation - Virtual Memory, Paging, Segmentation, Page Replacement Algorithms- First in First Out, Least Recently Used, Optimal Page Replacement Algorithm, Secondary Storage - Disk Structure, Disk Scheduling, Disk Management.

Self-Study	Solve a given page-reference string using FIFO, LRU and Optimal Page Replacement and compare page faults and page hits.
Text Book	Text Book 1: Chapters 9, 10 and 11

CIE Assessment Pattern (50 Marks – Theory)

RBT Levels		Marks Distribution		
		Test (s)	AAT1	AAT2
		25	15	10
L1	Remember	-	-	-
L2	Understand	5	5	-
L3	Apply	10	5	5
L4	Analyze	10	5	5
L5	Evaluate	-	-	-
L6	Create	-	-	-

SEE Assessment Pattern (50 Marks – Theory)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	-
L2	Understand	10
L3	Apply	20
L4	Analyze	20
L5	Evaluate	-
L6	Create	-

Suggested Learning Resources:

Text Books:

1) Abraham Silberschatz, Peter B. Galvin, and Greg Gagne, *Operating System Concepts*, 10th Edition, Wiley, 2021, ISBN: 978-1-119-80037-8
2) Brian Ward, *How Linux Works: What Every Superuser Should Know*, 3rd Edition, No Starch Press, 2021, ISBN: 978-1-7185-0040-2.
3) Jayant Varma, *Pro Bash: Learn to Script and Program the GNU/Linux Shell*, 3rd Edition, Apress, 2023, ISBN: 978-1-4842-9587-8.
4) Arnold Robbins, *Effective awk Programming*, 4th Edition, O'Reilly Media, 2015, ISBN: 978-1-4919-0461-9.

Reference Books:

1) Daniel J. Barrett, Linux Pocket Guide, 4th Edition, O'Reilly Media, Inc., 2024, ISBN: 978-1-098-15795-1.
2) Richard Petersen, Linux: The Complete Reference, 6th Edition, McGraw Hill Education, 2017, ISBN: 978-0-070-22294-6.

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/117106113
- https://onlinecourses.nptel.ac.in/noc21_cs72
- https://linuxcommand.org/tlcl.php

Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning:

- Problem-Based Learning: Solve real-world Linux and shell scripting problems
- Collaborative Learning: Work in groups on Linux tasks and scripting activities.
- Experiential Learning: Perform hands-on Linux commands and shell scripting exercises.

****

DATABASE MANAGEMENT SYSTEMS

Course Code	**26MC16**	**Credits**	**04**
L: T:P:S	**3:0:1:0**	**CIE Marks**	**50**
TLP Contact Hours / Sem	**42+28**	**SEE Marks**	**50**
TW & SL / Sem	**50**	**Total Marks**	**100**
Total Hours /Sem	**120**	**Exam Hours**	**03**

Course outcomes:
At the end of the course, the student will be able to:

26MC16.1	Summarize the fundamentals database system concept and architecture.
26MC16.2	Illustrate Relational database design using ER-Modelling for various applications.
26MC16.3	Apply the concepts of Relational Algebra using SQL.
26MC16.4	Apply SQL queries to extract relevant information from a given database.
26MC16.5	Derive procedures in PL/SQL to extend functionality of Database applications.

MODULE-1	**INTRODUCTION**	**26MC16.1**	**8 Hours**

Databases and Database Users-Database Characteristics, Actors/Workers, Advantages of using DBMS approach, Database System Concepts and Architecture - Data Models, Schemas, and Instances, Three-Schema Architecture and Data Independence, Database Languages and Interfaces, The Database System Environment-DBMS Component Modules, Classification of Database Management Systems, Relational Model Concepts-Domains, Attributes, Tuples, and Relations, Characteristics of Relations, Relational Model Notation.

Laboratory Component: **6 Hours**

1. Write and execute MySQL commands to create, select, modify, and delete databases and tables. *Demonstrate basic data manipulation operations such as INSERT, UPDATE, DELETE, and SELECT.*
2. *Use various MySQL data types by creating a suitable table and inserting appropriate values for numeric, character, date, time, decimal, and Boolean data types.*
3. *Write SQL queries to demonstrate MySQL date and time functions such as CURDATE(), CURTIME(), NOW(), DATE_ADD(), DATE_SUB(), DATEDIFF(), and DATE_FORMAT()*
4. *Write SQL queries to demonstrate string functions such as UPPER(), LOWER(), LENGTH(), CONCAT(), SUBSTRING(), and TRIM() using sample data.*
5. *Write SQL queries to demonstrate numeric functions such as ABS(), CEIL(), FLOOR(), ROUND(), OD(), and POWER() using sample values.*
6. *Write SQL queries to demonstrate control flow functions such as IF(), IFNULL(), NULLIF(), and CASE expressions using sample data*

Case Study	Identify the applications of DDL, DML, and DQL in an Use Case.
Text Book	Text Book 1: Chapter 1, Text Book 2: Chapter 1, 2

MODULE-2	**RELATIONAL MODEL AND DATA MODELING**	**26MC16.2**	**8 Hours**

Types of Constraints, Relational Database Schemas, Integrity, Referential Integrity and Foreign Keys, Update Operations, Transaction and Dealing with Constraint Violations. Data Modeling Using the Entity-Relationship (ER) Model-High-Level Conceptual Data Models for Database Design, A Sample Database Application, Entity Types, Entity Sets, Attributes, and Keys, Relationship Types, Relationship Sets, Roles, and Structural Constraints, Weak Entity Types, Naming Conventions and Design Issues in ER Diagrams, Relationship Types of Degree Higher than Two, Relational Database Design Using ER-to-Relational Mapping.

Laboratory Component: **4 Hours**

1. *Draw an ER diagram for Employee Management System using drawing tools.*
2. *Draw an ER diagram for Library Management System using drawing tools.*
3. *Draw an ER diagram for University Database System using drawing tools.*
4. *Draw an ER diagram for Tourism Management System using drawing tools.*

Case Study	Analyse the Keys and Constraints for *Tourism Management and Hotel Booking S*ystems.
Text Book	Text Book 1: Chapter 2, 7, Text Book 2: Chapter 3, 7

MODULE-3	**RELATIONAL OPERATIONS and SQL RETRIEVAL QUERIES**	**26MC16.3**	**8 Hours**

Unary Relational Operations-SELECT and PROJECT, Relational Algebra Operations from Set Theory, Binary Relational Operations-JOIN and DIVISION.

Basic SQL- SQL Data Definition and Data Types-The CREATE TABLE Command in SQL, Attribute Data Types and Domains in SQL, Specifying Constraints in SQL, Basic Retrieval Queries in SQL, INSERT, DELETE and UPDATE Statements in SQL, Aliasing, Substring Pattern Matching, Complex SQL Retrieval Queries-Nested Queries, Correlated Nested Queries, EXISTS and UNIQUE Functions in SQL, Types of Joins, Aggregate Functions in SQL, Grouping, Views in SQL.

Laboratory Component: **6 Hours**

1. *Student Database Management*
   - *Create a STUDENT table with the following attributes: RollNo, StudentName, Branch, Semester, CGPA, and Email.*
   - *Define appropriate data types and constraints for each attribute.*
   - *Insert at least five student records.*
   - *Display all student records and students belonging to a particular branch.*
   - *Add a new column PhoneNo.*
   - *Modify the data type of RollNo.*
   - *Update the CGPA of selected students.*
   - *Delete a particular student record.*
   - *Remove the Email column from the table.*
   - *Delete all records from the table and demonstrate the difference between DELETE and DROP.*
2. *Sales Database and Aggregate Operations*
   - *Create a SALES table with the following fields: SalesNo, SalesName, Branch, SalesAmount, and DOB.*
   - *Insert at least five records.*
   - *Display the salespersons belonging to each branch.*
   - *Calculate the total and average sales amount for each branch.*
   - *Find the maximum and minimum sales amount.*
   - *Display the salespersons whose sales amount is greater than the average sales amount.*
   - *Display the salespersons born in the month of December.*
   - *Display the branch-wise number of salespersons using appropriate aggregate and grouping operations.*
3. *Design a COLLEGE database containing STUDENT, FACULTY, DEPARTMENT, and COURSE tables.*
   - *Create all tables using appropriate data types and integrity constraints.*
   - *Insert sample records into each table.*
   - *Perform basic SELECT, INSERT, UPDATE, and DELETE operations.*
   - *Use aliasing and pattern matching to retrieve specific student and faculty information.*
   - *Use aggregate functions such as COUNT, SUM, AVG, MIN, and MAX with GROUP BY and HAVING.*
   - *Create suitable views for displaying student-course and faculty-department information.*

Application	Analyze the Database Operations in Online Bookstore Management Systems
Text Book	Text Book 1: Chapter 3, 4, Text Book 2: Chapter 4, 6

MODULE-4	**RELATIONAL DATABASE DESIGN AND TRANSACTION PROCESSING**	**26MC16.4**	**9 Hours**

Database Design - Informal Design Guidelines for Relation Schemas, Functional Dependencies, 1NF, 2NF, 3NF, Boyce-Codd Normal Form.

Transaction Processing – Concepts, Concurrent Transactions, Transaction and System Concepts, Schedules and Recoverability, Serializability of Schedules, Transaction Support in SQL, Concurrency Control Techniques, Locking Techniques for Concurrency Control-Two Phase Locking.

Laboratory Component: **6 Hours**

1. *Write an SQL query to find the total revenue, average revenue, minimum revenue, maximum revenue, and number of orders for each product in an e-commerce database using the Orders and Order_Details tables. Use appropriate JOIN and aggregate functions with GROUP BY.*
2. *Write SQL queries to demonstrate different types of JOIN operations (INNER JOIN, LEFT JOIN, RIGHT JOIN, and equivalent implementation of FULL OUTER JOIN) using the Products and Order_Details tables. Display suitable records to demonstrate the purpose of each join.*
3. *a) Create a Student table and demonstrate READ and WRITE table locks using LOCK TABLES and UNLOCK TABLES. Execute SELECT and UPDATE statements to observe the effect of each lock.*
4. *b) Demonstrate transaction management on the Student table using START TRANSACTION, COMMIT,*

	and ROLLBACK. Use SELECT ... FOR UPDATE to lock a specific student record and perform an update within the transaction		
Case Study	Explore Database Normalization and Concurrency Control through Online Banking and Fund Transfer.		
Text Book	Text Book 1: Chapter 8, Text Book 2: Chapter 5, 15		
MODULE-5	**INTRODUCTION TO PL/SQL**	**26MC16.5**	**9 Hours**

Basics of PL/SQL- Identifiers, Delimiters, Comments, Data Types, Basic Syntax, Control Statements, Loops-Labeling a PL/SQL Loop, Loop Control Statements, Cursors- Implicit Cursor, Explicit Cursors- Declaring the Cursor, Opening the Cursor, Fetching the Cursor, Closing the Cursor. Procedures- Creating a Procedure, Executing a Standalone Procedure, Deleting a Standalone Procedure, Parameter Modes in PL/SQL Subprograms, Functions-Creating a Function, Calling a Function, PL/SQL Recursive Functions, Exceptions-Syntax for Exception Handling, Raising Exceptions, User-defined Exceptions, Pre-defined Exceptions, Triggers-Benefits of Triggers, Working with Triggers.

Laboratory Component: **6 Hours**

1. *Employee Salary Processing Using Explicit Cursor:*
   Write a PL/SQL program to demonstrate the use of an explicit cursor to retrieve employee details and calculate revised salaries based on specified conditions
2. *Employee Bonus Calculation Using Function:*
   Write a PL/SQL program to create and execute a function to calculate the bonus of an employee based on salary and years of service.
3. *Student Result Processing Using Stored Procedure:*
   Write a PL/SQL program to create and execute a stored procedure to calculate and display the total marks, average marks, and result status of a student.

Case Study	Analyze the use of triggers and cursors in employee payroll and salary processing in an organization.
Text Book	Text Book 3: Chapter 4, 5, 6, 9, 11, 13

CIE Assessment Pattern (50 Marks – Theory)

RBT Levels		Marks Distribution		
		Test (s)	AAT1	Lab
		25	15	10
L1	Remember	-	-	-
L2	Understand	5	-	-
L3	Apply	10	10	10
L4	Analyze	10	5	-
L5	Evaluate	-	-	-
L6	Create	-	-	-

SEE Assessment Pattern (50 Marks – Theory)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	-
L2	Understand	10
L3	Apply	20
L4	Analyze	20
L5	Evaluate	-
L6	Create	-

Suggested Learning Resources

Text Books:

1) Abraham Silberschatz, Henry F. Korth, and S. Sudarshan, *Database System Concepts*, McGraw Hill, 7th Edition, 2021, ISBN: 978-0-07-802215-9.
2) Ramez Elmasri and Shamkant B. Navathe, *Fundamentals of Database Systems*, Pearson Education, 7th Edition, 2017, ISBN: 978-93-3258-270-5.
3) Benjamin Rosenzweig and Elena Rakhimov, *Oracle PL/SQL by Example*, Oracle Press, 6th Edition, 2023, ISBN: 978-0-13-806283-5.

Reference Books:

1) Carlos Coronel, Stephen Morris, and Peter Rob, *Database Principles: Fundamentals of Design, Implementation, and Management*, Cengage India Private Limited, 10th Edition, 2014, ISBN: 978-81-315-2593-7.
2) Niraj Gupta, *Oracle SQL and PL/SQL*, CreateSpace Independent Publishing Platform, 2015, ISBN: 978-1-5429-0144-4.

Web links and Video Lectures (e-Resources):

- www.scaler.com/topics/dbms
- https://www.coursera.org/learn/database-structures-and-management-with-mysql
- https://onlinecourses.swayam2.ac.in/ini24_cs01/preview

Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning

- Group discussion on designing a database for a Web Application.
- Student presentations on UML diagrams.

****

DATA STRUCTURES LAB			
Course Code	**26MCL17**	**Credits**	**1.5**
L:T:P:S	**0:0:1.5:0**	**CIE Marks**	**50**
TLP Contact Hours / Sem	**42**	**SEE Marks**	**50**
TW & SL / Sem	**03**	**Total Marks**	**100**
Total Hours /Sem	**45**	**Exam Hours**	**03**

Course outcomes:
At the end of the course, the student will be able to:

26MCL17.1	Demonstrate array, structure, sorting and searching techniques using C.
26MCL17.2	Use stack-based and recursive programming techniques.
26MCL17.3	Implement and demonstrate the operational aspects of linear and circular queues.
26MCL17.4	Implement stack, queue and doubly linked list using linked representations.
26MCL17.5	Implement and traverse binary search trees and demonstrate basic heap operations.

Pgm. No.	List of Programs	Hours	COs
	Prerequisite Programs		
	• Data Types and Operators in C • Control Statements in C • Conditional and Logical Operations • Writing Functions and Function Calls	3	NA
	PART-A		
1	Write a C program using structures to store and display the details of 'N' students such as USN, Name, Semester and Marks.	3	26MCL17.1
2	Write a C program to sort a given array in ascending order using: a) Selection Sort b) Bubble Sort.	3	26MCL17.1
3	Implement Linear Search and Binary Search techniques on a given array.	3	26MCL17.1
4	Write a C program that uses stack operations to convert a given infix expression into its postfix equivalent.	3	26MCL17.2
5	Write C programs using recursion for the following: a) Factorial of a number b) Fibonacci Series c) Tower of Hanoi.	3	26MCL17.2
6	Simulate the working of a Linear Queue data structure using an array.	3	26MCL17.3
	PART-B		
7	Implement the working of a Circular Queue data structure using an array.	3	26MCL17.3
8	Write a C program for linked list implementation of a Stack.	3	26MCL17.4
9	Write a C program for linked list implementation of a Queue.	3	26MCL17.4
10	Write a C program using functions to perform the following: a) Create a doubly linked list of elements. b) Insert and delete a given element. c) Display the contents of the list.	3	26MCL17.4
11	Write a C program using functions to create a Binary Search Tree of integers and traverse the tree in In-order, Pre-order and Post-order.	3	26MCL17.5
12	Write a C program to implement a Max-Heap and perform insertion, deletion and display operations.	3	26MCL17.5

PART-C
Beyond Syllabus Virtual Lab Content (3 Hours)
(To be done during Lab but not to be included for CIE or SEE)

1. To gain a basic understanding of stacks as an abstract data type, understand operations on stack with their applications. Students to complete the learning objectives using virtual laboratory link: https://ds1-iiith.vlabs.ac.in/exp/stacks-queues/stacks/stackdemo.html

2. To gain a basic understanding of polynomial representation using linked lists and perform polynomial addition, subtraction, and multiplication practically using the virtual laboratory link: https://ds1-iiith.vlabs.ac.in/exp/poly-arithmetic/index.html

3. To understand the working of the Depth First Traversal algorithm and practically perform node searching using the algorithm. https://ds1-iiith.vlabs.ac.in/exp/depth-first-search/index.html

4. To understand the need for hashing, learn the basic methods of hashing strings, and understand various techniques for handling collisions in hashing.
https://ds1-iiith.vlabs.ac.in/exp/hashtables/index.html

CIE Assessment Pattern (50 Marks – Lab)

RBT Levels		Test (s)	Weekly Assessment
		30	20
L1	Remember	-	-
L2	Understand	-	-
L3	Apply	20	10
L4	Analyze	10	10
L5	Evaluate	-	-
L6	Create	-	-

SEE Assessment Pattern (50 Marks – Lab)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	-
L2	Understand	-
L3	Apply	25
L4	Analyze	25
L5	Evaluate	-
L6	Create	-

Suggested Learning Resources:

Reference Books:

1) Ashok N. Kamthane, Data Structures Using C, Pearson India, May 2024, ISBN: 9781299444805.
2) E. Balagurusamy, Data Structures Using C, 2nd Edition, McGraw Hill Education, 2025, ISBN: 9789364443012.
3) Reema Thareja, Data Structures Using C, 3rd Edition, Oxford University Press, 2023, ISBN: 9789354977190.
4) Yedidyah Langsam, Moshe J. Augenstein and Aaron M. Tenenbaum, Data Structures Using C and C++, Pearson Education India, 2nd Edition, 2015, ISBN: 9789332549319.

****

OBJECT ORIENTED PROGRAMMING WITH JAVA LAB			
Course Code	**26MCL18**	**Credits**	**1.5**
L:T:P:S	**0:0:1.5:0**	**CIE Marks**	**50**
TLP Contact Hours / Sem	**42**	**SEE Marks**	**50**
TW & SL / Sem	**03**	**Total Marks**	**100**
Total Hours /Sem	**45**	**Exam Hours**	**03**

Course outcomes:
At the end of the course, the student will be able to:

26MCL18.1	Create a basic Java Program application using classes and objects with proper syntax and semantics.
26MCL18.2	Create an application for manipulating string and array elements.
26MCL18.3	Create an application using Inheritance, interfaces and packages.
26MCL18.4	Apply the concepts of Multithreading and Exception Handling to develop efficient and error free codes.
26MCL18.5	Develop programs using collections and AWT components.

Pgm. No.	List of Programs	Hours	COs
	Prerequisite Programs		
	• Core JAVA Programming • Basics of Core JAVA Programming	3	NA
	PART-A		
1	Write a Java Program to display employee pay slip using Class, Object and Method.	3	26MCL18.1
2	Write a Java Program to demonstrate Constructor Overloading and Method Overloading in one single Program.	3	26MCL18.1
3	Write a Java program to sort for an element in a given list of elements using Bubble Sort.	3	26MCL18.2
4	Write a Menu based Java program to implement any 5 String and StringBuffer methods.	3	26MCL18.2
5	Write a Java Program to handle simple Bank transaction using Inheritance.	3	26MCL18.3
6	Simple Program on Java for the implementation of Multiple inheritance using interfaces to calculate the area of a rectangle and triangle.	3	26MCL18.3
	PART-B		
7	Write a Java program to demonstrate Multithreading with Synchronization.	3	26MCL18.4
8	Write a Java program to create a package named shape, to create some classes in the package representing some common shapes like Square, Triangle, and Circle and import and compile these classes in other program.	3	26MCL18.4

9	Write a program to demonstrate the implementation of Exception Handling in Java.	3	26MCL18.4
10	Write a program to implement Queue from Java Collection.	3	26MCL18.5
11	Write a Java program to implement Linked List from Java Collection.	3	26MCL18.5
12	Write a Java program to create a student registration page using AWT components.	3	26MCL18.5

PART-C

Beyond Syllabus Virtual Lab Content (3 Hours)

(To be done during Lab but not to be included for CIE or SEE)

- To implement standard patterns of object creation
  https://oop-amrt.vlabs.ac.in/exp/standard-patterns-object-creation/
- To perform object-oriented analysis for the given scenario using use case document and object domain model. The students have to identify the objects, its internals, and the relationship among them for a given real-world scenario
  https://oop-amrt.vlabs.ac.in/exp/objects-classes-attributes/
- To implement inheritance relationship between classes in Java from the class diagram.
  https://oop-amrt.vlabs.ac.in/exp/inheritance-relationship/
- To implement exception handling and generic methods in the release vehicle use case in Java.
  https://oop-amrt.vlabs.ac.in/exp/parameterized-polymorphism

CIE Assessment Pattern (50 Marks – Lab)

RBT Levels		Test (s)	Weekly Assessment
		30	20
L1	Remember	-	-
L2	Understand	-	-
L3	Apply	20	10
L4	Analyze	10	10
L5	Evaluate	-	-
L6	Create	-	-

SEE Assessment Pattern (50 Marks – Lab)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	-
L2	Understand	-
L3	Apply	25
L4	Analyze	25
L5	Evaluate	-
L6	Create	-

Suggested Learning Resources:

Reference Books:

1) Kathy Sierra and Bert Bates, *Head First Java*, Shroff/O'Reilly Publication, 3rd Edition, 2022, ISBN: 978-93-5542-090-9.
2) Cay S. Horstmann, *Core Java Volume I – Fundamentals*, Prentice Hall, 12th Edition, 2021, ISBN: 978-0-13-767362-9.
3) Kogent Learning Solutions Inc., *Java 6 Programming Black Book*, Dreamtech Press, 2012, ISBN: 978-81-7722-997-4.

****

PROBLEM SOLVING METHODOLOGIES			
Course Code	**26MC19**	**Credits**	**00**
L:T:P:S	**0:0:0:0**	**CIE Marks**	**50**
TLP Contact Hours / Sem	**28**	**SEE Marks**	**00**
TW & SL / Sem	**32**	**Total Marks**	**PP**
Total Hours /Sem	**60**	**Exam Hours**	**00**

Course outcomes:
At the end of the course, the student will be able to:

26MC19.1	Demonstrate proficiency in solving quantitative aptitude problems using fundamental concepts
26MC19.2	Apply advanced quantitative techniques to address and solve complex real-world problems.
26MC19.3	Develop and enhance logical reasoning skills essential for problem-solving in various competitive examinations.
26MC19.4	Cultivate critical and creative thinking skills necessary for analytical reasoning and problem-solving.

MODULE-1	**CRITICAL THINKING THROUGH QUANTITATIVE ANALYSIS**	**26MC19.1, 26MC19.2**	**6 Hours**

Number Systems: LCM and HCF Of Numbers, Squaring and Cubing Techniques, Multiplication Tricks, Divisibility Rules, Digit Sum Method, Speed Math, Simplifications, Approximations.
Percentages: Conversion of Fraction to Percentage Table, Percentage Change, Net Percentage Change/Effective Percentage Change, Successive Percentage, Concept of More/Less Percentage, Percentage of Percentage, Product Constancy, Increased/Decreased by P%, Percentage Changes in Numerator and Denominator, Successive Percentage.
Averages: Basic Concept, Consecutive Numbers, Non-Consecutive Numbers, Equation Concept, True/False Concept, Including/Excluding Concept, Replacement Concept, Average Speed Concept.

Self-Study	Practice Exercises on Number Systems, Percentages and Averages through shortcuts, formulae, numerical and application-based problems.
Text Book	Text Book 1: Chapter 1, 2, 4, 5, 6, 11

MODULE-2	**NUMERICAL TECHNIQUES FOR PROBLEM SOLVING**	**26MC19.1, 26MC19.2**	**6 Hours**

Profit and Loss: Basic Concept, Profit Percentage, Loss Percentage, Profit/Loss Percentage, Overall Profit/Loss, Dishonest Shopkeeper, More/Less Loss Concept, Discounts
Ratio and Proportion: Concept Explanation, Duplicate Ratio, Triplicate Ratio, Direct Proportion, Indirect Proportion, Double Rule of Three or Compound Proportion, Ratio in Investment, Ratio in Partnership, Ratio in Averages, Ratio in Profit and Loss, Ratio in Interest Rates.
Ages: Ratio and Sum of Ages, Ratio and Product of Ages, Ratio of Present and Future Ages, Ratio of Past and Present Ages.
Partnership: Simple Partnership, Compound Partnership, Partnership at Will, Partnership For a Fixed Term, Particular Partnership, General Partnership, Limited Partnership, Limited Liability Partnership.

Self-Study	Practice Exercises on Profit and Loss, Ratio and Proportion, Ages, and Partnership through numerical and application-based problems.
Text Book	Text Book 1: Chapter 8, 12, 13, 14, 15

MODULE-3	**QUANTITATIVE TECHNIQUES**	**26MC19.1, 26MC19.2**	**6 Hours**

Time and Work: Unit Work, Combined Work, Individual Efficiency, Group Efficiencies, Time Taken by an Individual or a Group, Work Done by an Individual or a Group, Total Work Done, Chain Rule Concept, Pipes and Cisterns, 4 Rules of Pipes and Cistern.
Gamification: Switch Grid, Geo Sudoku, Grid Lock, Number Challenge, Cognitive Reasoning Games.
Cognitive Ability: Statements & Conclusions, Statements & Assertions, Statements & Assumptions, Causes & Effects and Flow Charts.

Self-Study	Practice problems on Time and Work, Pipes and Cisterns, Gamification, and Cognitive Ability through numerical, logical reasoning and problem-solving exercises.

Text Book	Text Book 1: Chapter 15, 16, 17,		
MODULE-4	**ANALYTICAL REASONING AND CREATIVE PROBLEM SOLVING**	**26MC19.3, 26MC19.4**	**6 Hours**
Number Series - Missing Numbers, Incomplete Series - Odd-Even Series, Primes, Fibonacci Series, Arithmetic Progression, Geometric Progression, Harmonic Progression, Squares and Cubes, Operations on Digits, Exponential Series, Increasing Multiplication, Hybrid Series. **Alphabetical Series**- Missing Alphabets, Incomplete Letter Series - Series of Words, Series of Letters, Arrangement of Words/Letters, Letters Marked with Corresponding Numbers Sequence, Positions of Letters, Ranking of the Word in Dictionary; Mixed Series - Missing Numbers and Words/Letters, Complete the Series. **Analogies:** Alphabet Classification, Word Classification, Number Classification. **Coding and Decoding:** Coding Based on Order, Letter to Letter Mapping, Letter to Number Mapping, Letter to Digit Mapping, Re-Ordering Sequences; Word Sequencing, Match the Word to Code, Symbol Coding.			
Self-Study	Practice Exercises on Number and Alphabetical Series, Analogies, Classification, and Coding-Decoding through missing series, sequences, patterns, mappings, arrangements, and logical reasoning problems.		
Text Book	Text Book 1: Chapter 35		
MODULE-5	**PROBLEM SOLVING THROUGH LOGICAL ANALYSIS**	**26MC19.3, 26MC19.4**	**6 Hours**
Directions: Eight Directions, Distance, Displacement, Starting and Ending Points, Referential Directions, Directions of Shadows, Axis Based Problems, Actual and Conditional Directions. **Seating Arrangements:** Linear Arrangement, Square Arrangement, Rectangular Arrangement, Circular Arrangement, Vertical Arrangement, Seating Arrangement in a Photograph, Tabular Arrangement, Hexagonal Seating Arrangement, Complex Arrangement, Miscellaneous Arrangements. **Blood Relations:** Relations Defined, Generation Verticals, Family Tree, Single Person Blood Relations, Mixed/Chain Blood Relations, Symbol Based Blood Relation.			
Self-Study	Practice problems on Directions, Seating Arrangements and Blood Relations through distance and displacement, directional reasoning, linear/circular/complex seating arrangements, family trees, generation-based relations, and symbol-based blood relation problems.		
Text Book	Text Book 2: Chapter		

CIE Assessment Pattern (50 Marks – Theory)

RBT Levels		Marks Distribution
		Test (s)
		50
L1	Remember	10
L2	Understand	20
L3	Apply	20
L4	Analyze	-
L5	Evaluate	-
L6	Create	-

Suggested Learning Resources:

Text Books:

1. Dr. R.S. Aggarwal, Quantitative Aptitude for Competitive Examinations, S. Chand Publishing, Latest Edition (2026), ISBN: 978-93-5870-501-0.
2. Arun Sharma, How to Prepare for Quantitative Aptitude for CAT, McGraw Hill Education, 9th Edition, 2024, ISBN: 978-93-5686-872-4.

Reference Books:

1. Sarvesh K. Verma, Quantum CAT: Quantitative Aptitude for CAT, Arihant Publications, 2026 Edition, ISBN: 978-9368404835.
2. Rajesh Verma, Fast Track Objective Arithmetic, Arihant Publications, Completely Revised Edition 2025–26, ISBN: 978-93-6840-665-5.
3. Dinesh Khattar, Quantitative Aptitude for Competitive Examinations, Pearson India, 4th Edition,

2022, ISBN: 978-93-5343-955-2.

Web links and Video Lectures (e-Resources):

- Freshers world: Aptitude & Reasoning
  https://www.youtube.com/results?search_query=Freshersworld+Aptitude+Reasoning
- Adda24/7: Aptitude & Reasoning
  https://www.youtube.com/results?search_query=Adda247+Quantitative+Aptitude+Reasoning

Activity-Based Learning (Suggested Activities in Class)/Practical Based Learning:

Activity	Aptitude Topic	Description
Math Relay Race	Percentages, Profit & Loss, Time & Work	Divide students into teams. Each student solves one question and passes the sheet to the next teammate. The first team to finish with the most correct answers wins.
Puzzle & Seating Challenge	Seating Arrangements, Logical Reasoning	Give each team a seating arrangement or logic puzzle. Teams compete to solve it within a fixed time.
DI Detective	Data Interpretation	Provide charts, graphs, or tables. Students answer questions individually or in groups, explaining how they arrived at their answers.
Human Number Line	Number System, Averages, Ratio & Proportion	Students hold number cards and physically arrange themselves to solve ordering, averages, ratios, or sequence-based problems.
Aptitude Quiz Bowl	Mixed Aptitude Topics	Conduct a quiz with multiple rounds (MCQs, rapid fire, visual reasoning, puzzles, and calculation challenges). Award points to teams and maintain a leader board.

(Mandatory Learning Course) A bridge course for graduates joined for MCA Programme without study of Mathematics at 10+2 level or at Graduation level			
FOUNDATION MATHEMATICS FOR COMPUTER APPLICATIONS			
Course Code	**26MT110**	**Credits**	**00**
L:T:P:S	**0:0:0:0**	**CIE Marks**	**50**
TLP Contact Hours / Sem	**42**	**SEE Marks**	**-**
TW & SL / Sem	**48**	**Total Marks**	**50**
Total Hours /Sem	**90**	**Exam Hours**	**-**

Course outcomes:
At the end of the course, the student will be able to:

26MT110.1	Understand the Basic Concepts in Matrices and Formulate the problems in Matrix expression.
26MT110.2	Widen the knowledge of Basic concepts in Set Theory and Apply the fundamentals of set theory and Relations to the given problem.
26MT110.3	Understand mathematical reasoning to read, comprehend and construct mathematical arguments.
26MT110.4	Determine the sum of the first n terms of an arithmetic and Geometric series.
26MT110.5	Get the basic concepts of probability and find the probability of simple and compound events.

MODULE-1	**MATRICES AND DETERMINANTS**	**26MT110.1**	**8 Hours**
Matrix Introduction, Types of Matrices, Scalar Multiplication, Addition of Matrices, Product of Matrices. Transpose of a Matrix, Symmetric and Skew Symmetric Matrix, Rank of a Matrix, and Determinant of a Matrix. Singular Matrix.			
Self-study	Inverse of a matrix.		
Text Book	Text Book 1: Chapter 2		
MODULE-2	**SET THEORY**	**26MT110.2**	**8 Hours**
Introduction. Representation of Sets, Types of Sets, Finite Set, Infinite Set, Equivalent Set, Disjoint Set, Subset, Power Set. Venn Diagram. Set Operations: Union, Intersection, Complement of a Set, Difference, Symmetric Difference. Laws of Set Theory. Cartesian Product of Sets, Relations and Properties.			
Self-study	Relations and properties in Real-Life Applications.		
Text Book	Text Book 1: Chapter 2		
MODULE-3	**LOGIC AND PROPOSITIONS**	**26MT110.3**	**8 Hours**
Logic Statement, Propositions, Connectives, Basic Logic Operations: Conjunction, Disjunction, Negation, Implication and Double Implication. Truth Table, Logical Equivalence/Equivalent Statements, Tautologies and Contradictions.			
Self-study	Identify and verify tautologies and contradictions using truth tables.		
Text Book	Text Book 1: Chapter 1		
MODULE-4	**SEQUENCE AND SERIES**	**26MT110.4**	**9 Hours**
Introduction, Sequences, Series, Arithmetic Progression, Sum of Finite Number of Terms in A.P, Arithmetic Means, Geometric Progression, Sum to N Terms of G.P, Geometric Mean, Relation Between A.M and G.M.			
Self-study	Applications of Arithmetic Progression and Geometric progression in Real Life.		
Text Book	Text Book 1: Chapter 2		
MODULE-5	**PROBABILITY THEORY**	**26MT110.5**	**9 Hours**
Probability: Introduction, Random Experiments, Sample Space, Events and Algebra of Events. Definitions of Probability – Classical, and Axiomatic. Conditional Probability, Laws of Addition and Multiplication, Independent Events, Theorem of Total Probability, Bayes' Theorem and its Applications.			
Self-study	Applications of Probability in Real Life.		
Text Book	Text Book 2: Chapter 1, 2 & 3		

CIE Assessment Pattern (50 Marks – Theory)

RBT Levels		Marks Distribution		
		Theory Tests	AAT1	AAT2
		25	15	10
L1	Remember	-	-	-
L2	Understand	5	-	-
L3	Apply	10	5	5
L4	Analyze	10	5	5
L5	Evaluate	-	5	-
L6	Create	-	-	-

Suggested Learning Resources:

Text Books:

1) Kenneth H Rosen, "Discrete Mathematics and its Applications", McGraw Hill publications, 7th edition ISBN: 978-0077418939.
2) Walpole Myers Ye "Probability and Statistics for engineers and Scientist" Pearson Education, 8th edition ISBN: 978-0132047678.

Reference Books:

1) Richard A Johnson and C. B Gupta "Probability and statistics for engineers" Pearson Education.
2) J.K Sharma "Discrete Mathematics", Mac Millan Publishers India, 3rd edition,2011.
3) Higher Engineering Mathematics, B. S. Grewal, Khanna Publishers, 43rd Edition, 2015.

Web links and Video Lectures (e-Resources):

- http://.ac.in/courses.php?disciplineID=111
- http://www.class-central.com/subject/math(MOOCs)
- http://academicearth.org/
- VTU EDUSAT PROGRAMME-20

Activity-Based Learning (Suggested Activities in Class)/Practical Based Learning:

- Contents related activities (Activity-based discussions)
  - Problem solving Approach
  - Organizing Group wise discussions on related topics
  - Seminars

***

SECOND SEMESTER
MCA SYLLABUS
(2026-27)

ADVANCED JAVA			
Course Code	**26MC21**	**Credits**	**03**
L:T:P:S	**3:0:0:0**	**CIE Marks**	**50**
TLP Contact Hours / Sem	**42**	**SEE Marks**	**50**
TW & SL / Sem	**48**	**Total Marks**	**100**
Total Hours /Sem	**90**	**Exam Hours**	**03**

Course outcomes:
At the end of the course, the student will be able to:

26MC21.1	Explain the fundamentals of Java Swing in creating Java GUI applications.
26MC21.2	Apply JDBC to perform database operations.
26MC21.3	Use Servlets for dynamic web application development.
26MC21.4	Examine the role of Java Server Pages (JSP), JavaBeans, and Java Server Pages Standard Tag Library (JSTL) in dynamic web application development.
26MC21.5	Investigate Spring Boot features for developing RESTful web applications.

MODULE-1	**SWING**	**26MC21.1**	**8 Hours**

Fundamentals, Components-Text Field, Label, Text Area, Password Field, Combo Box, Table, List, Option Pane, Scrollbar, Menu, Color Chooser, Radio Button, Checkbox. Components, Layout Managers, Event Handling.

Applications	Student Registration and Profile Management System using Java Swing
Text Book	Text Book 3: Chapter 15, 16, 17, 18, 19, 20, 21, 22

MODULE-2	**JAVA DATABASE CONNECTIVITY (JDBC)**	**26MC21.2**	**8 Hours**

Basic concepts, Driver Types, Packages, Connectivity Steps, Database Connection, Statement Objects, Result Set, Metadata, Data Types, Exceptions. JDBC and Embedded SQL- Tables, CRUD Operations, Store and Retrieve images.

Applications	Inventory Management System using Swing and Java Database Connectivity (JDBC)
Text Book	Text Book 2: Chapter 5, 6, 7

MODULE-3	**SERVLETS**	**26MC21.3**	**8 Hours**

Introduction, Uses of Servlet, Servlet Architecture, Web Container, The Servlet Life Cycle, Servlet API, Handling HTTP GET and POST Request, Exceptions, Servlet Config, Servlet Context, Cookies, Session Tracking, Servlet with JDBC.

Applications	Online Shopping Cart System using Java Servlets
Text Book	Text Book 2: Chapter 10, Text Book 1: 4, 8, 9

MODULE-4	**JAVA SERVER PAGES (JSP), JAVABEANS AND JAVASERVER PAGES STANDARD TAG LIBRARY (JSTL)**	**26MC21.4**	**9 Hours**

Introduction, Advantages of JSP, JSP Architecture, JSP life Cycle, Developing First JSP, Implicit Objects, JSP Scripting Elements-Directives, Declaratives, Scriptlets, Expressions, Implicit Variables, Page Directives, JSP Action Tags, JSP with JDBC. Java Beans- Advantages of Java Beans, The Java Beans API. A Bean Example, JSP with Java Beans.
JSTL: JSTL Expression Language, Core Tags, Formatting Tags, SQL Tags, XML Tags, Function Tags. Custom Tag Libraries: Tag Library Basics, Tag Library Descriptors (TLDs).

Applications	Online Food Ordering System using JSP, JavaBeans and JSTL
Text Book	Text Book 2: Chapter 11, Text Book 1: 12

MODULE-5	**INTRODUCTION TO SPRING BOOT AND RESTFUL WEB SERVICES**	**26MC21.5**	**9 Hours**

Enterprise Application Development, Introduction to Spring Framework, Introduction to Spring Boot, Features and Architecture of Spring Boot, Spring Initializer and Maven Project Structure, Spring Boot Project Structure, Inversion of Control (IoC) and Dependency Injection (DI), Spring Boot Annotations (@SpringBootApplication, @RestController, @Autowired), RESTful Web Services, HTTP Methods (GET, POST), Mapping Annotations (@GetMapping, @PostMapping), Request Parameters and Request Body, Configuration using Application. Properties, Development and Testing of a Simple REST API using Spring Boot and Postman.

Case Study	Development of a RESTful Web Service for an E-Commerce Application using Spring Boot.

Text Book	Text Book 4: Chapter 1, 5, 7

CIE Assessment Pattern (50 Marks – Theory)

RBT Levels		Marks Distribution		
		Test (s)	AAT1	AAT2
		25	15	10
L1	Remember	-	-	-
L2	Understand	5	5	3
L3	Apply	10	5	3
L4	Analyze	10	5	4
L5	Evaluate	-	-	-
L6	Create	-	-	-

SEE Assessment Pattern(50 Marks – Theory)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	-
L2	Understand	10
L3	Apply	20
L4	Analyze	20
L5	Evaluate	-
L6	Create	-

Suggested Learning Resources:

Text Books:

1) Marty Hall and Larry Brown, *Core Servlets and JavaServer Pages: Volume 1: Core Technologies*, Prentice Hall, 2nd Edition, 2013, ISBN: 978-0-130-09229-8.
2) Jim Keogh, *J2EE: The Complete Reference*, McGraw-Hill Education, 1st Edition, 2002, ISBN: 978-0-070-52912-5.
3) Kogent Learning Solutions Inc., *Java 6 Programming Black Book*, Dreamtech Press, 1st Edition, 2008, ISBN: 978-81-7722-736-9.
4) Craig Walls, *Spring in Action*, Manning Publications, 7th Edition, 2024, ISBN: 978-1-63343-851-4.

Reference Books:

1) Andrew Lee Rubinger and Bill Burke, *Developing Enterprise Java Components: Enterprise JavaBeans 3.1*, O'Reilly Media, 1st Edition, 2010, ISBN: 978-1-4493-9696-1.
2) Michael Sikora, *EJB 3 Developer Guide: A Practical Guide for Developers and Architects to the Enterprise JavaBeans Standard*, Shroff Publishers & Distributors Pvt. Ltd., 1st Edition, 2008, ISBN: 978-81-8404-530-7.
3) Mark Heckler, *Spring Boot: Up and Running*, O'Reilly Media, 2nd Edition, 2024, ISBN: 978-1-4920-7697-1.

Web links and Video Lectures (e-Resources)

- https://www.geeksforgeeks.org/introduction-java-servlets/
- https://www.javatpoint.com/java-jdbc
- https://www.tutorialspoint.com/jsp
- https://www.codingshuttle.com/spring-boot-handbook/spring-boot-tutorial-a-comprehensive-guide-for-beginners/

Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning

- Video demonstration of latest technologies in Java.
- Expert talk & Seminars

****

DESIGN AND ANALYSIS OF ALGORITHMS			
Course Code	**26MC22**	**Credits**	**03**
L:T:P:S	**3:0:0:0**	**CIE Marks**	**50**
TLP Contact Hours / Sem	**42**	**SEE Marks**	**50**
TW & SL / Sem	**48**	**Total Marks**	**100**
Total Hours /Sem	**90**	**Exam Hours**	**03**

Course outcomes:
At the end of the course, the student will be able to:

26MC22.1	Discuss fundamental concepts and terminology related to algorithms.
26MC22.2	Explain basic algorithm design techniques and their applications.
26MC22.3	Use algorithm design techniques to solve standard problems.
26MC22.4	Characterize the features of various graphical problems with the help of a suitable technique.
26MC22.5	Evaluate the limitations of algorithms and approaches to solve them.

MODULE-1	**INTRODUCTION AND ANALYSIS**	**26MC22.1**	**8 Hours**

Notion of Algorithm, Fundamental of Algorithmic Problem Solving, Important Problem Types, Basics of data structures. Fundamentals of the Analysis of Algorithm Efficiency-Analysis Framework, Asymptotic Notations and Basic Efficiency Classes, Mathematical Analysis of Recursive and Non-recursive Algorithms, Examples.

Self Study	Study of Big-O, Big-Ω, and Big-Θ notations and their use in analyzing algorithm efficiency.
Text Book	Text Book 1: Chapter 1, 2

MODULE-2	**BRUTE FORCE AND DIVIDE AND CONQUER**	**26MC22.2**	**8 Hours**

Selection Sort, Bubble Sort, String Matching, Exhaustive Search. Divide and Conquer- Merge sort, Quick sort, Binary Search, Binary Tree Traversals and Related Properties, Multiplication of Large Integers.

Application	String Matching in Search Engines.
Text Book	Text Book 1: Chapter 3, 4

MODULE-3	**DECREASE AND CONQUER AND SPACE AND TIME TRADEOFFS**	**26MC22.3**	**8 Hours**

Insertion Sort, Depth - First and Breadth-First Search, Topological Sorting, Algorithms for Generating Combinatorial Objects, Decrease by a Constant Factor Algorithms.
Space and Time Tradeoffs - Sorting by Counting, Input Enhancement in String Matching using Horspool's Algorithm, Hashing, B-Trees.

Case Study	Using Hashing for fast student record retrieval.
Text Book	Text Book 1: Chapter 5, 7

MODULE-4	**DYNAMIC PROGRAMMING AND GREEDY TECHNIQUE**	**26MC22.4**	**9 Hours**

Dynamic Programming - Computing a Binomial Coefficient, Warshall's and Floyd's Algorithms, Knapsack Problem. Greedy Technique - Prim's Algorithm, Kruskal's Algorithm, Dijkstra's Algorithm, Huffman Trees.

Self Study	Real time algorithms to be designed in the field of computer networks by using Greedy Technique.
Text Book	Text Book 1: Chapter 8, 9

MODULE-5	**LIMITATIONS AND COPING WITH THE LIMITATIONS OF ALGORITHM POWER**	**26MC22.5**	**9 Hours**

Introduction, Lower Bound Arguments, Decision Trees, P, NP and NP-complete Problems. Coping with the Limitations of Algorithm Power- Backtracking, N-Queens Problem, Hamiltonian Circuit Problem, Subset-Sum Problem. Branch-and-Bound -Knapsack problem, Travelling Salesman Problem, Assignment problem.

Case Study	Comparison analysis can be done based on both techniques by using real time applications.
Text Book	Text Book 1: Chapter 11, 12

CIE Assessment Pattern (50 Marks – Theory)

RBT Levels		Marks Distribution		
		Test (s)	AAT1	AAT2
		25	15	10
L1	Remember	-	-	-
L2	Understand	5	5	2
L3	Apply	10	5	4
L4	Analyze	10	5	4
L5	Evaluate	-	-	-
L6	Create	-	-	-

SEE Assessment Pattern (50 Marks – Theory)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	-
L2	Understand	10
L3	Apply	20
L4	Analyze	20
L5	Evaluate	-
L6	Create	-

Suggested Learning Resources:

Text Book:

1) Anany Levitin, *Introduction to the Design and Analysis of Algorithms*, Pearson Education, 3rd Edition, 2021, ISBN: 978-0-13-754113-3.

Reference Books:

1) Sandeep Sen and Amit Kumar, *Design and Analysis of Algorithms*, Cambridge University Press, 2019, ISBN: 978-1-108-49682-0.
2) Parag H. Dave and Himanshu B. Dave, *Design and Analysis of Algorithms*, Pearson Education, 2009, ISBN: 978-81-7758-595-7.
3) Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein, *Introduction to Algorithms*, MIT Press, 3rd Edition, 2009, ISBN: 978-0-262-03384-8.
4) Sushil C. Dimri, Preeti Malik, and Mangey Ram, *Algorithms: Design and Analysis*, De Gruyter, 2021, ISBN: 978-3-11-069375-1.
5) Ellis Horowitz, Sartaj Sahni, and Sanguthevar Rajasekaran, *Fundamentals of Computer Algorithms*, Galgotia Publications, 2nd Edition, 2008, ISBN: 978-81-7515-257-1.

Web links and Video Lectures (e-Resources)

- https://nptel.ac.in/courses/106101060
- https://onlinecourses.nptel.ac.in/noc19_cs47/preview
- https://www.coursera.org/specializations/algorithms

Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning

- Examining the performance of sorting algorithms with their implications.
- Examining the applications of Dijkstra's algorithm in computer networks.

****

SOFTWARE ENGINEERING AND AGILE DEVELOPMENT			
Course Code	**26MC23**	**Credits**	**03**
L:T:P:S	**3:0:0:0**	**CIE Marks**	**50**
TLP Contact Hours / Sem	**42**	**SEE Marks**	**50**
TW & SL / Sem	**48**	**Total Marks**	**100**
Total Hours /Sem	**90**	**Exam Hours**	**03**

Course outcomes:
At the end of the course, the student will be able to:

26MC23.1	Explain the fundamental concepts of Software Engineering, software processes, and various software process models.
26MC23.2	Analyze software requirements using requirements engineering processes and requirements modeling techniques.
26MC23.3	Examine the evolution of Agile methodologies and various Agile frameworks.
26MC23.4	Apply the Scrum framework using its core components.
26MC23.5	Discuss the principles and practices of Agile-based software design, development, and testing.

MODULE-1	**INTRODUCTION TO SOFTWARE ENGINEERING**	**26MC23.1**	**8 Hours**

The Nature of Software, The Unique Nature of WebApps, Software Engineering: The Software Process, Software Engineering Practice, Software Development Myths. Software Process Structure: A Generic Process Model, Process Assessment and Improvement, Prescriptive Process Models: Waterfall Model, Incremental Process Models, Evolutionary Process Models, Concurrent Models, Specialized Process Models. Unified Process, Personal and Team process models.

Case Study	A college plans to develop a Web-based Event Management System for managing event details, student registrations, attendance, and feedback. Select a suitable software process model for developing the system and explain how the different phases of the selected model can be applied. Justify the choice considering user requirements, future changes, and feedback.
Text Book	Text Book 1: 1.1, 1.2, 2.2-2.4, 4.1-4.4

MODULE-2	**REQUIREMENTS ENGINEERING AND REQUIREMENTS MODELING**	**26MC23.2**	**8 Hours**

Understanding Requirements: Requirements Engineering, Software Requirements Specification, Establishing the Groundwork, Eliciting Requirements, Developing Use Cases, Building the Requirements Model, Negotiating Requirements, Validating Requirements. Requirements Modeling: Requirement Analysis, Scenario-Based Modeling, UML Models that Supplement the Use Case, Class-Based Modeling, Behavioral Modeling.

Case Study	A hotel plans to develop an Online Room Booking System where customers can view rooms, make bookings, and check booking status. Identify the system requirements and prepare suitable use cases, UML class model, and behavioral model.
Text Book	Text Book 1: 9.1-9.3,10.1-10.5,11.1-11.3

MODULE-3	**FUNDAMENTALS OF AGILE PROCESS**	**26MC23.3**	**8 Hours**

Definition of Agility, Agility and the Cost of Change, Traditional Model vs. Agile Model, Agile Manifesto-Values and Principles, Overview of Agile Development Models: Scrum, Extreme Programming, Dynamic Systems Development Method, Agile Unified Process, Feature Driven Development, Crystal, and Lean Software Development.

Case Study	A hospital wants to develop an Online Appointment Booking System where patients can book, cancel, and reschedule appointments. Requirements may change based on patient and doctor feedback. Explain how an Agile approach can handle these changing requirements and recommend a suitable Agile model.
Text Book	Text Book 1: 5.1-5.5 Text Book 2: 1.1,1.2

MODULE-4	**SCRUM FRAMEWORK**	**26MC23.4**	**9 Hours**

Introduction to Scrum, Scrum Artifacts, Meetings, Activities and Roles, Scrum Team Simulation, Scrum Planning Principles, Product and Release Planning, Sprinting: Planning, Execution, Review and Retrospective; User Story Definition and Characteristics, Acceptance Tests and Verifying Stories, Burn Down Chart, Daily Scrum.

Case Study	A travel company wants to develop an online tour booking system using Scrum. Identify suitable user stories, prepare a product backlog, and plan a sprint with suitable Scrum

	activities.		
Text Book	Text Book 3: 1, 2, 4, 5, 7, 14, 17, 18, 19, 20, 21, 22		
MODULE-5	**AGILE DESIGN, DEVELOPMENT AND TESTING**	**26MC23.5**	**9 Hours**

Agile Design Practices, Role of Design Principles, Need and Significance of Refactoring, Refactoring Techniques, Continuous Integration, Automated Build Tools, Version Control; Agility and Quality Assurance: Agile Interaction Design, Agile Approach to Quality Assurance, Test Driven Development, Pair Programming: Issues and Challenges.

Applications	• An automation program to test whether a test case has passed or failed. • A program to read the contents of an excel file and printing the contents on the selenium output console using jxl. • Program to count the total number of hyperlink objects present on a webpage.
Text Book	Text Book 2: 2.7-2.11

CIE Assessment Pattern (50 Marks – Theory)

RBT Levels		Marks Distribution		
		Test (s)	AAT1	AAT2
		25	15	10
L1	Remember	-	-	-
L2	Understand	10	5	5
L3	Apply	5	5	5
L4	Analyze	10	5	-
L5	Evaluate	-	-	-
L6	Create	-	-	-

SEE Assessment Pattern (50 Marks – Theory)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	-
L2	Understand	20
L3	Apply	10
L4	Analyze	20
L5	Evaluate	-
L6	Create	-

Suggested Learning Resources:

Text Books:

1) Roger S. Pressman, Bruce R. Maxim, Software Engineering-A Practitioner's Approach, 8th Edition, Mc Graw Hill, 2015, ISBN: 9780078022128.
2) Robert C. Martin, Agile Software Development- Principles, Patterns and Practices, 1st Edition Prentice Hall, 2013, ISBN: 9780135974445.
3) Kenneth S. Rubin, Essential Scrum: A Practical Guide to the Most Popular Agile Process, 1st Edition, Addison Wesley, 2012, ISBN: 9780137043293.

Reference Books:

1) Lisa Crispin, Janet Gregory, Agile Testing-A Practical Guide for Testers and Agile Teams, Addison Wesley, 2009, ISBN: 9780321534460.
2) Ken Schawber, Mike Beedle, "Agile Software Development with Scrum", International Edition, Pearson Education, 2002, ISBN: 9780130676344.

Web links and Video Lectures (e-Resources):

- https://onlinecourses.nptel.ac.in/e-learning/preview/noc24_cs119
- https://www.youtube.com/playlist?list=PLPaj_o9gjMYlUy99004bZVOF9yCKZLx9I
- https://www.youtube.com/watch?v=9TycLR0TqFA

Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning

- Expert talk on topics like Industry perspectives on Agile Development in the Real World.
- Brainstorming session on usage of tools and techniques in projects undertaken in current semester.
- Assign pairs to write and review each other's code based on a user story using Test-Driven Development approach.

****

ADVANCED JAVA LAB			
Course Code	**26MCL24**	**Credits**	**1**
L:T:P:S	**0:0:1:0**	**CIE Marks**	**50**
TLP Contact Hours / Sem	**28**	**SEE Marks**	**50**
TW & SL / Sem	**02**	**Total Marks**	**100**
Total Hours /Sem	**30**	**Exam Hours**	**03**

Course outcomes:
At the end of the course, the student will be able to:

26MCL24.1	Explain the fundamentals of Java Swing in creating Java GUI application.
26MCL24.2	Apply JDBC to perform database operations.
26MCL24.3	Use Servlets to develop dynamic web applications.
26MCL24.4	Examine the use of Java Server Pages (JSP), JavaBeans, and Java Server Pages Standard Tag Library (JSTL) in dynamic web application development.
26MCL24.5	Investigate Spring Boot features for developing RESTful web applications.

Pgm. No.	List of Programs	Hours	COs
	Prerequisite Programs		
	• Basics of Object-Oriented Programming • Core Java Programming	2	NA
	PART-A		
1	Write a Java program to open and save a file in different location.	2	26MCL24.1
2	Create a Java Swing application to display the student's performance card.	2	26MCL24.1
3	Write a Java JDBC program to develop a Library Management System that allows users to add, search, update, and delete book records from a database.	2	26MCL24.2
4	Write a Java Servlet Program to implement get and post method	2	26MCL24.3
5	Write a Java Servlet Program to implement verification of a particular user login and display a welcome page using MYSQL.	2	26MCL24.3
6	Write a Java Servlet Program using cookies to remember user preference.	2	26MCL24.3
	PART-B		
7	Write a Java Servlet Program to implement sessions (Using HTTP Session Interface).	2	26MCL24.3
8	Write a Java JSP Program which uses jsp:include and jsp:forward action to display a webpage.	2	26MCL24.3
9	Write a Java JSP Program to implement mail registration page using MYSQL.	2	26MCL24.4
10	Write a Java JSP Program to get student information through a HTML and create a JAVA Bean Class, populate Bean and display the same information through another JSP.	2	26MCL24.4
11	Develop a Spring Boot application to implement a Customer Management REST API using @GetMapping and @PostMapping annotations.	2	26MCL24.5
12	Develop a Spring Boot application to implement a Vehicle Registration REST API that accepts vehicle registration	2	26MCL24.5

	details and retrieves the registered vehicle information using RESTful web services.		

PART-C

Beyond Syllabus Virtual Lab Content (2 Hours)

(To be done during Lab but not to be included for CIE or SEE)

- To demonstrate database connectivity using JDBC and perform CRUD operations such as insert, update, delete, and retrieve records. Students to complete the learning objectives using the online practice resource: https://sqliteonline.com/
- To understand Servlet programming and implement HTTP GET and POST requests for handling user input in a web application. Students to complete the learning objectives using the online reference resource: https://github.com/anirudhagaikwad/Servlet_SpringBoot/tree/master/Practicals/ServletRquestMethods_Example
- To understand Spring Boot project development and implement a simple RESTful web service using controllers, HTTP methods, and request handling. Students to complete the learning objectives using the online reference resource: https://start.spring.io/
- To develop and test RESTful web services using Spring Boot and analyze HTTP requests and responses using an API testing tool. Students to complete the learning objectives using the online practice resource: https://www.postman.com/

CIE Assessment Pattern (50 Marks – Lab)

RBT Levels		Test (s)	Weekly Assessment
		30	20
L1	Remember	-	-
L2	Understand	-	-
L3	Apply	20	15
L4	Analyze	10	5
L5	Evaluate	-	-
L6	Create	-	-

SEE Assessment Pattern (50 Marks – Lab)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	-
L2	Understand	-
L3	Apply	40
L4	Analyze	10
L5	Evaluate	-
L6	Create	-

Suggested Learning Resources

Reference Books:

1) Andrew Lee Rubinger and Bill Burke, *Developing Enterprise Java Components: Enterprise JavaBeans 3.1*, O'Reilly Media, 2010, ISBN: 978-1-4493-9696-1.
2) Michael Sikora, *EJB 3 Developer Guide: A Practical Guide for Developers and Architects to the Enterprise JavaBeans Standard*, Shroff Publishers & Distributors Pvt. Ltd., 2008, ISBN: 978-81-8404-530-7.
3) Prasanalakshmi B., *Advanced Java Programming*, CBS Publishers, 1st Edition, 2015, ISBN: 978-81-239-2383-3.
4) Mark Heckler, *Spring Boot: Up and Running*, O'Reilly Media, 2nd Edition, 2024, ISBN: 978-1-4920-7697-1.

****

DEVOPS LAB			
Course Code	**26MCL25**	**Credits**	**01**
L:T:P:S	**0:0:1:0**	**CIE Marks**	**50**
TLP Contact Hours / Sem	**28**	**SEE Marks**	**50**
TW & SL / Sem	**02**	**Total Marks**	**100**
Total Hours /Sem	**30**	**Exam Hours**	**03**

Course outcomes:
At the end of the course, the student will be able to:

26MCL25.1	Explain DevOps principles and AWS cloud fundamentals.
26MCL25.2	Apply Git and GitHub for version control and collaboration.
26MCL25.3	Use AWS to configure CI/CD pipelines for automation.
26MCL25.4	Identify key components for containerization with Docker and automation.
26MCL25.5	Examine cloud monitoring with AWS Cloud Watch and IAM-based security in DevOps workflows.

Pgm. No.	List of Programs	Hours	Cos
	Prerequisite Programs		
	• Configure basic IAM roles and attach them to a user. • Explore AWS Management Console and list any commonly used services and install Git and initialize a local repository.	2	NA
	PART-A		
1	Create a free-tier AWS account and launch your first EC2 instance.	2	26MCL25.1
2	Create an S3 bucket and upload/download a file from it.	2	26MCL25.1
3	Create a GitHub account and push a local project to a remote repository. Perform commit, push, and pull operations using Git CLI.	2	26MCL25.1
4	Create a new branch in GitHub, make changes, and merge it with the main branch.	2	26MCL25.2
5	Integrate GitHub with AWS CodePipeline and test repository trigger.	2	26MCL25.2
6	Create a CodeCommit repository and push your code into it.	2	26MCL25.3
	PART-B		
7	Set up AWS CodeDeploy to deploy an app to EC2 using a simple AppSpec file.	2	26MCL25.3
8	Create a CI/CD pipeline using AWS CodePipeline that builds and deploys an app automatically.	2	26MCL25.3
9	Create a Dockerfile for a basic web server and build an image.	2	26MCL25.4
10	Push the Docker image to Amazon ECR.	2	26MCL25.4
11	Create a CloudWatch dashboard to monitor CPU usage of an EC2 instance.	2	26MCL25.5

12	Set up an alarm in CloudWatch that sends a notification when CPU exceeds 60%.	2	26MCL25.5

PART-C

Beyond Syllabus Virtual Lab Content (2 Hours)

(To be done during Lab but not to be included for CIE or SEE)

- Practise staging files, committing changes, creating branches, and resolving basic version-control tasks in an interactive terminal. https://shellgenius.com/
- Build a Docker image, run a container and verify the running application using an interactive lab. https://training.play-with-docker.com/
- Create a basic pipeline, execute build stages, and examine the build results. https://tasklab.prodevopsguytech.com/

CIE Assessment Pattern (50 Marks – Lab)

RBT Levels		Test (s)	Weekly Assessment
		30	20
L1	Remember	-	-
L2	Understand	-	5
L3	Apply	20	10
L4	Analyze	10	5
L5	Evaluate	-	-
L6	Create	-	-

SEE Assessment Pattern (50 Marks – Lab)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	-
L2	Understand	-
L3	Apply	25
L4	Analyze	25
L5	Evaluate	-
L6	Create	-

Suggested Learning Resources:

Text Books:

1) Gene Kim, Jez Humble, Patrick Debois, John Willis, *"The DevOps Handbook: How to Create World-Class Agility, Reliability, & Security in Technology Organizations"*, 2nd Edition, IT Revolution Press, 2021, ISBN-13: 978-1950508405.
2) Len Bass, Ingo Weber, Liming Zhu, *"DevOps: A Software Architect's Perspective"*, 1st Edition, Addison-Wesley, 2015, ISBN-13: 978-0134049847.

Reference Books:

1) Jez Humble, David Farley, *"Continuous Delivery: Reliable Software Releases through Build, Test, and Deployment Automation"*, 1st Edition, Addison-Wesley, 2010, ISBN-13: 978-0321601919.

****

CYBER SECURITY SPECIALIZATION	
Course Code	**Course Name**
26MCCS26	CYBER SECURITY AND ETHICAL HACKING
26MCCS27	CRYPTOGRAPHY AND NETWORK SECURITY
26MCCSL28	ETHICAL HACKING LAB
26MCCSL29	CRYPTOGRAPHY AND NETWORK SECURITY LAB

CYBER SECURITY AND ETHICAL HACKING			
Course Code	**26MCCS26**	**Credits**	**03**
L:T:P:S	**3:0:0:0**	**CIE Marks**	**50**
TLP Contact Hours / Sem	**42**	**SEE Marks**	**50**
TW & SL / Sem	**48**	**Total Marks**	**100**
Total Hours /Sem	**90**	**Exam Hours**	**03**

Course outcomes:
At the end of the course, the student will be able to:

26MCCS26.1	Understand the cyber threats such as phishing, malware and network attacks targeting individuals and organizations.
26MCCS26.2	Demonstrate understanding of various attack surfaces, including wireless networks, cloud infrastructure and password vulnerabilities.
26MCCS26.3	Apply attacker techniques such as encryption cracking, network tapping and unauthorized account access.
26MCCS26.4	Apply cloud and wireless security techniques to identify vulnerabilities and implement appropriate defense mechanisms.
26MCCS26.5	Analyze cryptographic techniques, hashing mechanisms, key protection methods, and risk factors to identify vulnerabilities and appropriate security controls.

MODULE-1	**INTRODUCTION TO CYBERSECURITY AND NETWORK ATTACK FUNDAMENTALS**	**26MCCS26.1**	**8 Hours**

Introduction to Cybersecurity, Black Hat and White Hat Hackers, Cybersecurity Landscape and Emerging Threats. Internet Attack Targets, Fundamentals of Internet Operations, Black Hat Attack Methodology, Identification and Targeting of users, Protection Against Cyber Attacks, Network Analysis and Monitoring.

Self-Study	Cyberattack on a College Network – Understanding common cyber threats and preventive security measures.
Text Book	Text Book 1: Chapter 1, 2

MODULE-2	**PHISHING ATTACKS, MALWARE THREATS AND DEFENSIVE TECHNIQUES**	**26MCCS26.2**	**8 Hours**

Phishing Tactics: Introduction to Phishing, Vishing and Other Non-Email Phishing Techniques, Protection Against Phishing Attacks, Online Hoaxes, Phishing Motivations, and Analysis of Phishing Emails.
Malware Infections: Introduction to Malware, Types of Malware, Malware Deployment Techniques, Malware Protection and Prevention, Malware Analysis, and Antivirus Configuration and Management.

Case Study	Analyze a Fake Bank Account Verification Email as a Phishing Attack and Explain the Security Measures to Detect and Prevent It.
Text Book	Text Book 1: Chapter 3, 4

MODULE-3	**ACCOUNT SECURITY, NETWORK ATTACKS AND DEFENSIVE MECHANISMS**	**26MCCS26.3**	**8 Hours**

Password Thefts and Other Account Access Tricks: Authentication, Authorization, Accounting, Setting Up Accounts in Windows 10 and Macos.
Network Tapping: The Basics of Network Design, Attacking the Network, Defense Against Network Attacks, Setting up the Firewall.

Self-Study	Securing Online Banking Accounts Against Unauthorized Access – Analysis of password theft, authentication mechanisms, account security, and preventive measures against unauthorized access.
Text Book	Text Book 1: Chapter 5, 6

MODULE-4	**CLOUD, WEB AND WIRELESS NETWORK SECURITY**	**26MCCS26.4**	**9 Hours**

Attacks in the Cloud: Fundamentals of Cloud Computing, Cloud Attack Techniques, Cloud Security and Defense Mechanisms, and SQL Injection Testing using the Damn Vulnerable Web Application (DVWA). Wireless Network Pirating: Fundamentals of Wireless Networks, Wireless Standards, Wireless Security Mechanisms, Wireless Attack Techniques, Secure Wireless Network Configuration and Wireless Access Point (WAP) Security.

Application	**Hands-on Activity:** SQL injection testing using DVWA and secure WAP configuration.		
Text Book	Text Book 1: Chapter 7, 8		
MODULE-5	**CRYPTOGRAPHY, DATA SECURITY AND CYBER RISK MANAGEMENT**	**26MCCS26.5**	**9 Hours**

Encryption Cracking: Fundamentals of Cryptography, Encryption Concepts and Applications, Evolution of Cryptography, Modern Cryptographic Techniques, Secure Communication Through Websites, Protection of Cryptographic Keys, Password Hash Cracking Techniques, Salting of Hashes, File Encryption and Hashing. Defeating Black Hats: Cybersecurity Risks and Potential Impacts, Security Controls, Risk Management Programs, Integrated Cybersecurity Defense Strategies and Risk Analysis Methodologies.

Self- Study	Cybersecurity Threat Detection and Prevention in Banking Systems Using PKI, Digital Signatures, SSL/TLS, Password Protection, Risk Assessment, Defense-in-Depth, and Incident Response.
Text Book	Text Book 1: Chapter 9, 10

CIE Assessment Pattern (50 Marks – Theory)

RBT Levels		Marks Distribution		
		Test (s)	AAT1	AAT2
		25	15	10
L1	Remember	-	-	-
L2	Understand	10	5	4
L3	Apply	10	5	3
L4	Analyze	5	5	3
L5	Evaluate	-	-	-
L6	Create	-	-	-

SEE Assessment Pattern (50 Marks – Theory)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	-
L2	Understand	20
L3	Apply	20
L4	Analyze	10
L5	Evaluate	-
L6	Create	-

Suggested Learning Resources:

Text Books:

1) **Sam Grubb**, *How Cybersecurity Really Works: A Hands-On Guide for Total Beginners*, No Starch Press, 2021, ISBN: 978-1-7185-0128-7.

Reference Books:

1) **EC-Council**, *Ethical Hacking and Countermeasures: Attack Phases*, Cengage Learning, 2009, ISBN: 978-1-1117-8698-4.
2) **Michael T. Simpson, Kent Backman, and James E. Corley**, *Hands-On Ethical Hacking and Network Defense*, 2nd Edition, Course Technology/Cengage Learning, 2010, ISBN: 978-1-1331-6903-1.

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=fNzpcB7ODxQ
- https://www.youtube.com/watch?v=uHU2uajL1EE
- https://www.youtube.com/watch?v=K6V7fc5Hj2s
- https://archive.nptel.ac.in/courses/106/105/106105217/

Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning

- Students can choose one of the following activities: Capture the Flag (CTF) Competition, SQL Injection Challenge, Phishing Simulation, Social Engineering Role-Play, Security Policy Creation, Incident Response Simulation, Cryptography Challenge, Ethics Debate etc.

****

CRYPTOGRAPHY AND NETWORK SECURITY			
Course Code	**26MCCS27**	**Credits**	**03**
L:T:P:S	**3:0:0:0**	**CIE Marks**	**50**
TLP Contact Hours / Sem	**42**	**SEE Marks**	**50**
TW & SL / Sem	**48**	**Total Marks**	**100**
Total Hours /Sem	**90**	**Exam Hours**	**03**

Course outcomes:
At the end of the course, the student will be able to:

26MCCS27.1	Explain the principles of classical cryptographic techniques and number- theoretic concepts.
26MCCS27.2	Compare the working principles, applications and security characteristics of symmetric and asymmetric cryptographic algorithms.
26MCCS27.3	Apply cryptographic techniques for message authentication, key exchange and digital signatures.
26MCCS27.4	Analyze security mechanisms, protocols and policies used for network security.
26MCCS27.5	Evaluate wireless network security threats, attacks and security protocols, and recommend appropriate countermeasures.

MODULE-1	**CLASSICAL CRYPTOSYSTEM**	**26MCCS27.1**	**8 Hours**

Classical Cryptography Fundamentals: Security Trends, Security Attacks and Services, Classical Encryption Techniques, Symmetric Cipher Model, Substitution and Transposition Techniques, Caesar Cipher, Affine Cipher, Vigenère Cipher, LFSR Sequences, Basic Number Theory, Congruences, Chinese Remainder Theorem, Modular Exponentiation, Fermat's and Euler's Theorems, Legendre and Jacobi Symbols, Finite Fields.

Case study	Case study on Affine Cipher for E-Commerce.
Text Book	Text Book 1: Chapters 2, 3, 5; Text Book 2: Chapters 1, 2, 3

MODULE-2	**MODERN SYMMETRIC AND ASYMMETRIC CRYPTOGRAPHY**	**26MCCS27.2**	**8 Hours**

Modern Cryptographic Algorithms: Block Ciphers, Feistel Structure, Data Encryption Standard (DES), Triple DES (3DES) – Overview and Limitations, Modes of Operation – Electronic Code Book (ECB), Cipher Block Chaining (CBC), Cipher Feedback (CFB), Output Feedback (OFB) and Counter (CTR) Mode, Advanced Encryption Standard (AES) – Structure, Transformation Functions and Key Expansion, Stream Ciphers, RC4 – Overview and Security Limitations, Principles of Public-Key Cryptography, RSA.

Case study	Case study on Choosing a Modern Encryption Algorithm.
Text Book	Text Book 1: Chapters 4, 6, 7, 8, 9; Text Book 2: Chapters 5, 6, 7

MODULE-3	**MESSAGE AUTHENTICATION AND DIGITAL SIGNATURES**	**26MCCS27.3**	**8 Hours**

Message Authentication and Integrity: Message Authentication Requirements, Message Authentication Codes (MAC), Hash Functions, Secure Hash Algorithms (SHA-2 and SHA-3), MD5 – Overview and Security Limitations, Birthday Attack; Digital Signatures: Digital Signatures, RSA Digital Signature, Digital Signature Algorithm (DSA), ElGamal Signature; Key Exchange and Management: Diffie-Hellman Key Exchange, Key Management; Applications of Digital Signatures.

Case study	Case Study on Digital Certificate and E-Governance System
Text Book	Text Book 1: Chapter 11, 12, 13, 15

MODULE-4	**APPLICATION AND NETWORK SECURITY**	**26MCCS27.4**	**9 Hours**

Secure Communication and Application Security: Authentication and Key Management, Kerberos, X.509 Certificates, Public Key Infrastructure (PKI), Electronic Mail Security – Pretty Good Privacy (PGP), IP Security – Overview, Security Architecture and Policies, Authentication Header (AH), Encapsulating Security Payload (ESP), Internet Key Exchange (IKE), Virtual Private Networks (VPN), Transport Layer Security (TLS) – Architecture, Record Protocol, Handshake Protocol, Authentication and Key Establishment, Overview of TLS 1.3, Web Security – Threats and Countermeasures.

Self-Study	Explain how would you use Kerberos and TLS together to secure an enterprise application?
Text Book	Text Book 1: Chapter 15, 16, 17, 19, 20, 21

MODULE-5	**WIRELESS NETWORK SECURITY**	**26MCCS27.5**	**9 Hours**

Security Threats, Protocols and Countermeasures: Network Security Threats and Attacks, Denial-of-Service (DoS) and Distributed Denial-of-Service (DDoS) Attacks, Firewall Architecture and Types, Intrusion Detection

and Prevention Systems (IDS/IPS), Secure Network Communication, Wireless Network Security, IEEE 802.11 Wireless LAN Security, Wireless Authentication and Encryption, WPA2 and WPA3, Common Wireless Attacks and Countermeasures.

Self-Study	How would you design a secure IEEE 802.11 WLAN for an organization?
Text Book	Text Book 1: Chapter 18, 21

CIE Assessment Pattern (50 Marks – Theory)

RBT Levels		Marks Distribution		
		Test (s)	AAT1	AAT2
		25	15	10
L1	Remember	-	-	-
L2	Understand	10	5	5
L3	Apply	10	5	5
L4	Analyze	5	5	-
L5	Evaluate	-	-	-
L6	Create	-	-	-

SEE Assessment Pattern(50 Marks – Theory)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	-
L2	Understand	20
L3	Apply	20
L4	Analyze	5
L5	Evaluate	5
L6	Create	-

Suggested Learning Resources:

Text Books:

1) William Stallings, "Cryptography and Network security Principles and Practices", Pearson/PHI, 8th edition, 2023, ISBN: 9789357059718.
2) Wade Trappe, Lawrence C Washington, "Introduction to Cryptography with coding theory", 3rd ed, Pearson, 2020, ISBN: 9780135260166.

Reference Books:

1) W. Mao, "Modern Cryptography – Theory and Practice", Pearson Education, Second Edition, 2007, ISBN:0-13-066943-1.
2) Charles P. Pfleeger, Shari Lawrence Pfleeger, "Security in computing", Third Edition – Prentice Hall of India, 2006, ISBN: 978013408504-3.
3) Douglas R. Stinson. "Cryptography, theory and practice", 4th Edition, CRC Press, 2019, ISBN: 9780367148591.

Web links and Video Lectures (e-Resources):

- NPTEL – Cryptography and Network Security: https://onlinecourses.nptel.ac.in/noc22_cs90/preview
- SWAYAM – Cryptography and Network Security: https://onlinecourses.swayam2.ac.in/cec22_cs15/

Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning

- Demonstration and hands-on implementation of classical encryption techniques such as Caesar, Affine, Vigenere and Transposition ciphers.
- Implementation and analysis of RSA and DES/AES encryption and decryption.
- Hands-on implementation and demonstration of Diffie-Hellman key exchange, message authentication and digital signatures.
- Case-study based analysis of security protocols and mechanisms such as TLS, IPSec and PKI.
- Video demonstrations/discussions on emerging technologies and current trends in web and network security.

****

ETHICAL HACKING LAB			
Course Code	**26MCCSL28**	**Credits**	**1.5**
L:T:P:S	**0:0:1.5:0**	**CIE Marks**	**50**
TLP Contact Hours / Sem	**42**	**SEE Marks**	**50**
TW & SL / Sem	**03**	**Total Marks**	**100**
Total Hours /Sem	**45**	**Exam Hours**	**03**

Course outcomes:
At the end of the course, the student will be able to:

26MCCSL28.1	Apply operating system and network reconnaissance techniques to gather system, network, DNS, host, port, and service information using appropriate cybersecurity tools.
26MCCSL28.2	Analyze network traffic, phishing emails, malware indicators, authentication mechanisms, ARP activity, and firewall controls to identify potential security threats.
26MCCSL28.3	Demonstrate secure assessment techniques for web, wireless, and network environments by identifying common vulnerabilities such as SQL Injection, Cross-Site Scripting (XSS), and insecure configurations.
26MCCSL28.4	Apply cryptographic, password-security, and digital forensic techniques to protect information, verify data integrity, and analyze digital evidence using appropriate tools.
26MCCSL28.5	Evaluate cybersecurity vulnerabilities and risks and prepare an ethical hacking/security assessment report with appropriate mitigation and security recommendations.

Pgm. No.	List of Programs	Hours	COs
	Prerequisite Programs / Demo		
	• Basic Linux/Windows command-line operations and system administration. • Basic IP configuration and network connectivity testing using Ping, ARP and related commands	3	NA
	PART-A		
1	• Use suitable Windows/Linux commands to collect system information and present the results with appropriate screenshots. • Execute appropriate Windows/Linux network commands and analyze the information obtained.	3	26MCCSL28.1
2	• Identify and analyze A, AAAA, MX, NS and CNAME records and perform forward and reverse DNS lookups. • Execute Tracert/Traceroute for selected authorized destinations and interpret the hop-by-hop results.	3	26MCCSL28.1
3	• Perform host discovery on the given laboratory network and document the identified active hosts • Analyze the scanning results and prepare a report identifying the detected services and potential security considerations.	3	26MCCSL28.1
4	• Capture network packets and identify protocols such as ARP, ICMP, TCP, UDP and DNS from the captured traffic. • Apply appropriate Wireshark filters and analyze packet headers, source and destination addresses, ports, protocol information and communication patterns.	3	26MCCSL28.2
5	• Examine the sender information, subject, hyperlinks, attachments, language, urgency and other suspicious characteristics to identify phishing indicators.	3	26MCCSL28.2

	• Examine fields such as From, Reply-To, Received, Message-ID, SPF, DKIM and DMARC and determine the approximate route followed by the email.		
6	• Classify the malware as appropriate and identify relevant file, process, registry/system and network indicators from the provided controlled dataset. • Configure appropriate security settings, perform a controlled security scan using approved test files or datasets, and analyze the detection, quarantine and alert mechanisms.	3	26MCCSL28.2
PART-B			
7	• Create users and groups, assign permissions to files/folders, test authorized and unauthorized access, and document the results. • Generate hashes for sample passwords, apply salting, compare the resulting hash values, and analyze how salting improves password security.	3	26MCCSL28.2
8	• Monitor ARP activity, identify suspicious mapping changes, analyze the alerts generated, and suggest appropriate mitigation measures. • Create appropriate allow/deny rules for selected ports or services, test the rules, and analyze their effectiveness in controlling network traffic.	3	26MCCSL28.2
9	• Identify the web server, technologies/frameworks, HTTP response headers and other relevant information using appropriate browser tools or security tools. • Mirror the provided training website, examine its HTML, CSS, JavaScript and other resources, host the content locally, and document the observations.	3	26MCCSL28.3
10	• Use an authorized training application such as DVWA to identify the vulnerability, analyze the underlying cause, observe its impact, and recommend appropriate prevention techniques. • Identify the vulnerable input, analyze the security impact in the controlled environment, and recommend measures such as input validation and output encoding to prevent XSS.	3	26MCCSL28.3
11	• Configure the SSID, authentication and encryption settings, review WPS and access controls, and assess the security of the wireless configuration. • Encrypt and decrypt a sample file, generate its hash value before and after modification, compare the hash values, and analyze how hashing helps detect data tampering.	3	26MCCSL28.3 26MCCSL28.4
12	• Load the forensic image, examine the file system, identify deleted or relevant files, analyze metadata and hashes, perform keyword searches, and generate a forensic report. • Perform information gathering, network/service analysis and vulnerability identification using the permitted laboratory environment. Classify the identified risks, recommend appropriate security controls and prepare a structured security assessment report.	3	26MCCSL28.4 26MCCSL28.5
PART-C **Beyond Syllabus Virtual Lab Content (3 Hours)** **(To be done during Lab but not to be included for CIE or SEE)** • To perform network reconnaissance and analyze DNS, IP addressing, network services and routing			

information in a controlled environment.
Virtual laboratory link: https://tryhackme.com/path/outline/cybersecurity101

- To capture and analyze network traffic and identify protocols, packet headers, source and destination addresses, ports and communication patterns using a network analysis tool.
  Virtual laboratory link: https://tryhackme.com/path/outline/cybersecurity101
- To identify and analyze common web application vulnerabilities such as SQL Injection and Cross-Site Scripting in a controlled and authorized environment, and recommend appropriate mitigation techniques. Virtual laboratory link: https://portswigger.net/web-security
- To analyze web application requests and responses, identify security weaknesses, and practice vulnerability testing using an authorized web security testing environment.
  Virtual laboratory link: https://portswigger.net/web-security/all-labs

CIE Assessment Pattern (50 Marks – Lab)

RBT Levels		Test (s)	Weekly Assessment
		30	20
L1	Remember	-	-
L2	Understand	-	-
L3	Apply	20	15
L4	Analyze	10	5
L5	Evaluate	-	-
L6	Create	-	-

SEE Assessment Pattern (50 Marks – Lab)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	-
L2	Understand	-
L3	Apply	40
L4	Analyze	10
L5	Evaluate	-
L6	Create	-

Suggested Learning Resources
Reference Books:

1) William Stallings and Lawrie Brown, *Computer Security: Principles and Practice*, 5th Edition, 2024, ISBN: 978-0-13-809167-5.
2) Bill Nelson, Amelia Phillips, and Christopher Steuart, *Guide to Computer Forensics and Investigations*, 7th Edition, 2024, ISBN: 978-0-357-67288-4.
3) Georgia Weidman, *Penetration Testing: A Hands-On Introduction to Hacking*, 1st Edition, No Starch Press, 2014, ISBN: 978-1-59327-564-8.
4) Michael Sikorski and Andrew Honig, *Practical Malware Analysis: The Hands-On Guide to Dissecting Malicious Software*, 1st Edition, No Starch Press, 2012, ISBN: 978-1-59327-290-6.

****

CRYPTOGRAPHY AND NETWORK SECURITY LAB			
Course Code	**26MCCSL29**	**Credits**	**1.5**
L:T:P:S	**0:0:1.5:0**	**CIE Marks**	**50**
TLP Contact Hours / Sem	**42**	**SEE Marks**	**50**
TW & SL / Sem	**03**	**Total Marks**	**100**
Total Hours /Sem	**45**	**Exam Hours**	**03**

Course outcomes:
At the end of the course, the student will be able to:

26MCCSL29.1	Demonstrate the application of classical cryptographic techniques and number-theoretic concepts for secure message processing.
26MCCSL29.2	Apply symmetric and asymmetric cryptographic algorithms for encryption and decryption of data.
26MCCSL29.3	Implement cryptographic techniques for message authentication, key exchange and digital signature generation and verification.
26MCCSL29.4	Develop secure application and network communication using appropriate security mechanisms and protocols.
26MCCSL29.5	Analyze wireless network security threats and evaluate appropriate security mechanisms and countermeasures.

Pgm. No.	List of Programs	Hours	COs
	Prerequisite Programs / Demo		
	• Installation and configuration of Python/Java programming environment and required cryptographic libraries. • Familiarization with program execution and basic network/socket programming environment.	3	NA
	PART-A		
1	• Write a program to implement Caesar Cipher for encryption and decryption of a given message. • Write a program to implement Affine Cipher for encryption and decryption of a given message.	3	26MCCSL29.1
2	• Write a program to implement Vigenère Cipher for encryption and decryption using a given keyword. • Write a program to implement Transposition Cipher for encryption and decryption of a given message.	3	26MCCSL29.1
3	• Write a program to implement the Extended Euclidean Algorithm to find the greatest common divisor and multiplicative inverse of two integers. • Write a program to implement the Chinese Remainder Theorem (CRT) for a given set of congruences.	3	26MCCSL29.1
4	• Demonstrate DES encryption and decryption using a cryptographic library. • Demonstrate Triple DES (3DES) encryption and decryption using a cryptographic library.	3	26MCCSL29.2
5	• Write a program to implement AES encryption and decryption using a given secret key. • Write a program to implement the RC4 stream cipher for encryption and decryption of a given message.	3	26MCCSL29.2
6	• Demonstrate RSA key generation, encryption and decryption for a given message using a cryptographic library.	3	26MCCSL29.3

	• Demonstrate Diffie-Hellman key exchange and generate a shared secret key between two users.		
PART-B			
7	• A Generate MD5 hash of a given text and verify message integrity. • Generate SHA-256 hash of a given text and verify message integrity.	3	26MCCSL29.3
8	• Generate SHA-3 hash of a given text and compare it with SHA -256. • Implement HMAC for message authentication using a secret key	3	26MCCSL29.3
9	• Generate and verify an RSA digital signature using a cryptographic library. • Generate and verify a DSA digital signature using a cryptographic library	3	26MCCSL29.3
10	• Demonstrate secure message exchange using RSA public and private keys between two users. • Read and display the details of an X.509 digital certificate, including issuer, subject, validity period and public key.	3	26MCCSL29.4
11	• Develop a simple client-server application using sockets to exchange messages between a client and server. • Demonstrate TLS/SSL communication using Java/Python libraries and examine the security parameters and digital certificate.	3	26MCCSL29.4
12	• Implement a wireless security scenario to identify possible security threats/attacks and demonstrate suitable countermeasures.	3	26MCCSL29.5

PART-C

Beyond Syllabus Virtual Lab Content (3 Hours)

(To be done during Lab but not to be included for CIE or SEE)

- To analyze classical cryptanalysis and One-Time Pad security through virtual experiments: https://cse29-iiith.vlabs.ac.in/
- To explore modern cryptography, authentication, secure communication, and network security protocols through virtual simulations: https://vlab.co.in/
- To study network security attacks and countermeasures including SYN Flood, eavesdropping, replay attacks, Kerberos, SSL, firewalls, and IDS: https://new.vlab.co.in/computer-science-and-engineering/network-security-virtual-lab-213
- To explore and analyze cryptographic algorithms and security mechanisms through virtual experiments: https://vlab.iitg.ac.in/cryptography/

CIE Assessment Pattern (50 Marks – Lab)

RBT Levels		Test (s)	Weekly Assessment
		30	20
L1	Remember	-	-
L2	Understand	-	5
L3	Apply	20	10
L4	Analyze	10	5
L5	Evaluate	-	-
L6	Create	-	-

SEE Assessment Pattern (50 Marks – Lab)

RBT Levels		Exam Marks Distribution (50)
L1	**Remember**	**-**
L2	**Understand**	**-**
L3	**Apply**	**25**
L4	**Analyze**	**25**
L5	**Evaluate**	**-**
L6	**Create**	**-**

Suggested Learning Resources

Reference Books:

1) Cryptography and Network Security: Principles and Practice, William Stallings, 8th Edition, Pearson Education India, 2023, ISBN: 9789357059718
2) Cryptography and Network Security, Behrouz A. Forouzan and Debdeep Mukhopadhyay, 3rd Edition, McGraw Hill Education (India) Private Limited, 2018, ISBN: 9789339220945.
3) Network Security Essentials: Applications and Standards, William Stallings, 6th Edition, Pearson Education India, 2018, ISBN: 9789352866601
4) Cryptography: Theory and Practice, Douglas R. Stinson, Maura B. Paterson, 4th Edition, CRC Press, 2019, ISBN: 9780367148591.

****

DATA SCIENCE SPECIALIZATION	
Course Code	**Course Name**
26MCDS26	ARTIFICIAL INTELLIGENCE AND AGENTIC AI
26MCDS27	DATA SCIENCE AND VISUALIZATION
26MCDSL28	AGENTIC AI LAB
26MCDSL29	DATA SCIENCE AND VISUALIZATION LAB

ARTIFICIAL INTELLIGENCE AND AGENTIC AI			
Course Code	**26MCDS26**	**Credits**	**03**
L: T:P:S	**3:0:0:0**	**CIE Marks**	**50**
TLP Contact Hours / Sem	**42**	**SEE Marks**	**50**
TW & SL / Sem	**48**	**Total Marks**	**100**
Total Hours /Sem	**90**	**Exam Hours**	**03**

Course outcomes:
At the end of the course, the student will be able to:

26MCDS26.1	Explain the fundamentals of AI and intelligent agents.
26MCDS26.2	Apply search, knowledge representation and planning techniques to solve AI problems.
26MCDS26.3	Apply Generative AI, LLMs and prompt engineering techniques.
26MCDS26.4	Analyze Agentic AI architectures, memory, tools and RAG.
26MCDS26.5	Identify multi-agent systems, workflows and responsible AI practices.

MODULE-1	**AI FOUNDATIONS AND INTELLIGENT AGENTS**	**26MCDS26.1**	**8 Hours**

Introduction to Artificial Intelligence, Evolution and Applications of AI, Intelligent Agents, Agent and Environment, Rational Agents, PEAS Representation, Task Environments, Types of Intelligent Agents, Problem Formulation, State-Space Representation, Problem-Solving Agents, Introduction to Search Techniques. Wumpus World: Environment, Percepts, Knowledge and Action Selection.

Case Study	Study a multi-agent research system to understand workflows, agent roles, collaboration, delegation, evaluation, and responsible AI.
Text Book	Text Book 1: 7 Text Book 2: Chapters 1, 2

MODULE-2	**SEARCH, KNOWLEDGE REPRESENTATION AND PLANNING**	**26MCDS26.2**	**8 Hours**

Breadth First Search, Depth First Search, Heuristic Search, Generate and Test, Hill Climbing, Best First Search, A* Search. Knowledge Representation using Propositional Logic and First-Order Predicate Logic, Knowledge Bases, Knowledge-Based Agents, Knowledge Engineering. Introduction to AI Planning, Goal-Based Planning, State-Space Planning, Plan Generation and Planning in Intelligent Agents.

Case Study	Construct a small knowledge base using Propositional and First-Order Predicate Logic.
Text Book	Text Book 1: Chapters 3, 4, 7, 8, 10, 11 Text Book 2: Chapters 2, 3, 4

MODULE-3	**GENERATIVE AI AND LARGE LANGUAGE MODELS**	**26MCDS26.3**	**8 Hours**

Introduction to Generative AI; Traditional AI versus Generative AI; Applications of Generative AI; Foundation Models and Large Language Models; Basic concepts of Tokens, Embeddings and Context Windows; Conceptual Overview of Transformers; Capabilities and Limitations of LLMs; Hallucination. Prompt Engineering: Introduction to Prompt Engineering; Zero-Shot and Few-Shot Prompting; Role-Based Prompting; Structured Prompts; Prompt Chaining; Introduction to Context Engineering; Structured Outputs and Function Calling. Case Study: Using an LLM to Develop a Simple AI Assistant for Question Answering and Content Generation.

Self-Study	Design and compare Zero-Shot, Few-Shot, Role-Based, and Structured prompts to identify the most effective technique.
Text Book	Text Book 3: Chapter 2, Chapter 4

MODULE-4	**FUNDAMENTALS OF AGENTIC AI**	**26MCDS26.4**	**9 Hours**

Evolution from AI to Generative AI to Agentic AI; Generative AI versus Agentic AI; AI Assistants versus AI Agents; Characteristics of AI Agents; Autonomous and Semi-Autonomous Agents; Basic Agentic AI Architecture. Components of an AI Agent: Goal, Context, Reasoning, Planning, Memory, Tools, Knowledge and Actions; Simple Agent Workflow: Goal to Plan to Use Tools to Act to Feedback. Introduction to Agent Memory; Short-Term and Long-Term Memory; Conversational and Persistent Memory with Simple Examples. Introduction to Retrieval-Augmented Generation (RAG); Need for RAG; Basic RAG Architecture; Document Retrieval and Context Augmentation; Introduction to Embeddings and Vector Databases; Limitations of RAG; Introduction to Agentic RAG.

Case Study	Study a research-assistant case to understand Generative AI, Agentic AI, agent architecture, memory, tools, planning, RAG, embeddings, vector databases, and Agentic RAG.
Text Book	Text Book 3: Chapters 1, 3 and 5

MODULE-5	MULTI-AGENT SYSTEMS AND RESPONSIBLE AI	26MCDS26.5	9 Hours

Introduction to Agentic Workflows; Sequential and Parallel Workflows; Task Decomposition and Human-in-the-Loop; Introduction to Multi-Agent Systems; Single-Agent versus Multi-Agent Systems; Agent Roles and Responsibilities; Communication and Collaboration among Agents; Introduction to Delegation and Supervisor Agents; Basic Evaluation of AI Agents using Accuracy, Task Success and Reliability; Responsible AI: Hallucination, Prompt Injection, Data Privacy, Security, Human Oversight and Ethical Issues; Applications of Agentic AI in Research, Education, Coding, Data Analysis and Business.

Case Study	Analyse a multi-agent system for task decomposition, workflows, agent collaboration, delegation, evaluation, and responsible AI risks.
Text Book	Text Book 3: Chapters 1, 6, 7, 8, 9

CIE Assessment Pattern (50 Marks – Theory)

RBT Levels		Marks Distribution		
		Test (s)	AAT1	AAT2
		25	15	10
L1	Remember	-	-	-
L2	Understand	10	-	-
L3	Apply	5	5	5
L4	Analyze	10	10	5
L5	Evaluate	-	-	-
L6	Create	-	-	-

SEE Assessment Pattern (50 Marks – Theory)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	-
L2	Understand	20
L3	Apply	10
L4	Analyze	20
L5	Evaluate	-
L6	Create	-

Suggested Learning Resources:

Text Books:

1) Stuart Russell and Peter Norvig, *Artificial Intelligence: A Modern Approach*, 4th Edition, Pearson Education, 2021, ISBN: 978-93-5606-357-0
2) Ela Kumar, *Artificial Intelligence*, 1st Edition, Wiley India, 2020, ISBN: 978-93-89795-13-4.
3) Tom Taulli and Gaurav Deshmukh, *Building Generative AI Agents: Using LangGraph, AutoGen, and CrewAI*, Apress, 2025, ISBN: 979-8-8688-1133-3 (Print), 979-8-8688-1134-0

Reference Books:

1) E. Rich, K. Knight, and S. B. Nair, *Artificial Intelligence*, McGraw Hill, 3rd Edition, 2017, ISBN: 978-0-07-008770-5.
2) Dan W. Patterson, *Introduction to Artificial Intelligence and Expert Systems*, Pearson Education India, 2016, ISBN: 978-93-3255-194-7.
3) Numa Dhamani and Maggie Engler, *Introduction to Generative AI*, 2nd Edition, Manning Publications, 2025/2026, ISBN: 978-1-63343-488-2.

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/106102220
- https://microsoft.github.io/ai-agents-for-beginner
- https://learn.microsoft.com/en-us/ai

Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning

- Classroom Activity: Identify whether a given application is Traditional AI, Generative AI or Agentic AI.
- Group Discussion: Generative AI applications, benefits and limitations.
- Prompt Engineering Activity: Students give the same question using zero-shot, few-shot, role-based

and structured prompts and compare the responses.

- Build an agent on paper Activity: Students identify the goal, memory, tools and actions of a given AI agent.

****

DATA SCIENCE AND VISUALIZATION			
Course Code	**26MCDS27**	**Credits**	**03**
L:T:P:S	**3:0:0:0**	**CIE Marks**	**50**
TLP Contact Hours / Sem	**42**	**SEE Marks**	**50**
TW & SL / Sem	**48**	**Total Marks**	**100**
Total Hours /Sem	**90**	**Exam Hours**	**03**

Course outcomes:
At the end of the course, the student will be able to:

26MCDS27.1	Explain the foundations of Data Science, types of data and the data science lifecycle.
26MCDS27.2	Apply statistical and probability concepts for analyzing and interpreting data.
26MCDS27.3	Perform exploratory and statistical analysis on real-world datasets.
26MCDS27.4	Apply data mining techniques to discover patterns and identify outliers.
26MCDS27.5	Create appropriate visualizations and dashboards to communicate data-driven insights.

MODULE-1	**DATA ANALYTICS FOUNDATIONS AND DATA PREPARATION**	**26MCDS27.1**	**8 Hours**

Data Science Foundations – Introduction, Data Science Lifecycle, Applications, Data Analytics - Types of Analytics – Descriptive, Diagnostic, Predictive and Prescriptive Analytics. Data and Data Sources – Structured, Semi-structured and Unstructured Data, Quantitative and Qualitative Data, Levels of Measurement – Nominal, Ordinal, Interval and Ratio. Data Preparation – Data Sources, Data Quality, Missing Values, Duplicate Records, Outliers, Data Transformation, Data Integration and Data Wrangling.

Application	Data Quality Assessment and Data Preparation of a Real-World Dataset
Text Book	Text Book 1: Chapters 1, 2, 4 Text Book 3: Chapters 1, 2

MODULE-2	**STATISTICAL METHODS FOR DATA ANALYSIS**	**26MCDS27.2**	**8 Hours**

Descriptive Statistics – Mean, Median and Mode, Range, Variance, Standard Deviation and Covariance, Probability – Basic Concepts, Rules of Probability, Bayes' Theorem. Probability Distributions – Random Variables, Binomial Distribution, Poisson Distribution and Normal Distribution. Statistical Inference – Population and Sample, Sampling Methods, Confidence Intervals. Hypothesis Testing – Null and Alternative Hypotheses, Type-I and Type-II Errors, One-tailed and Two-tailed Tests, t-Test and Chi-Square Test.

Case Study	Statistical analysis of a real-world dataset and selection of appropriate statistical techniques.
Text Book	Text Book 1: Chapters 2, 5, 7 Text Book 2: Chapters 5, 6, 8, 10

MODULE-3	**EXPLORATORY DATA ANALYSIS AND STATISTICAL ANALYSIS**	**26MCDS27.3**	**8 Hours**

Exploratory Data Analysis – Need for EDA, Univariate Analysis, Bivariate Analysis, Multivariate Analysis, Distribution Analysis, Relationship Analysis, Correlation Analysis, Identification of Patterns and Trends. Statistical Analysis of Relationships – Correlation Analysis, Simple Linear Regression, Regression Equation and Interpretation of Regression Results. Time-Series Data Analysis, Dimensionality Reduction - Principal Component Analysis (PCA).

Self-Study	Time-Series Data Analysis – Identification of Trends and Seasonality in Real-World Data.
Text Book	Text Book 1: Chapters 6, 8, 9 Text Book 2: Chapter 4

MODULE-4	**DATA MINING CONCEPTS AND TECHNIQUES**	**26MCDS27.4**	**9 Hours**

Data Mining Foundations - Data Mining Process, Knowledge Discovery and Applications. Pattern Discovery – Frequent Itemsets, Support, Confidence, Association Rules. Association Rule Mining – Apriori Algorithm, Frequent Itemset Generation, Rule Generation and Interpretation. Outlier Analysis – Concept of Outliers, Statistical Approach, Distance-based Approach.

Case Study	Market Basket Analysis and identification of significant patterns and outliers in real-world datasets.
Text Book	Text Book 3: Chapters 1, 4, 11

MODULE-5	**DATA VISUALIZATION AND ANALYTICAL COMMUNICATION**	**26MCDS27.5**	**9 Hours**

Principles of Data Visualization – Purpose of Visualization, Principles of Effective Visualization, Selection of Appropriate Visualization. Data Visualization Techniques – Bar Charts, Line Charts, Histograms, Scatter Plots, Box Plots and Heat Maps. Analytical Visualization – Comparison, Distribution, Relationship and Trend Visualization. Interactive Visualization – Filters, Sorting, KPI Visualization and Interactive Dashboards. Data Storytelling and Communication – Dashboard Design Principles, Interpretation of Visualizations.

Case Study	Development and presentation of an analytical dashboard using a real-world dataset.
Text Book	Text Book 4: Chapters 1 - 4, 7, 8

CIE Assessment Pattern (50 Marks – Theory)

RBT Levels		Marks Distribution		
		Test (s)	AAT1	AAT2
		25	15	10
L1	Remember	-	-	-
L2	Understand	5	3	2
L3	Apply	10	6	4
L4	Analyze	10	6	4
L5	Evaluate	-	-	-
L6	Create	-	-	-

SEE Assessment Pattern (50 Marks – Theory)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	-
L2	Understand	10
L3	Apply	20
L4	Analyze	20
L5	Evaluate	--
L6	Create	--

Suggested Learning Resources:

Text Books:

1) Jeffrey D. Camm, James J. Cochran, Michael J. Fry and Jeffrey W. Ohlmann, Business Analytics, 5th Edition, Cengage Learning, 2024. ISBN: 978-0-357-90220-2.
2) Michael Sullivan III, Statistics: Informed Decisions Using Data, 7th Edition, Pearson, 2024. ISBN: 978-0-13-825333-2.
3) Jiawei Han, Jian Pei and Hanghang Tong, Data Mining: Concepts and Techniques, 4th Edition, Morgan Kaufmann (Elsevier), 2022. ISBN: 978-0-12-811760-6.
4) Joshua N. Milligan, Learning Tableau 2022, 5th Edition, Packt Publishing, 2022. ISBN: 978-1-80107-232-8.

Reference Books:

1) Wes McKinney, Python for Data Analysis: Data Wrangling with pandas, NumPy, and Jupyter, 3rd Edition, O'Reilly Media, 2022. ISBN: 978-1-098-10403-0.
2) Jack A. Hyman, Luca Massaron, Paul McFedries, John Paul Mueller, Jonathan Reichental, Joseph Schmuller, Alan R. Simon and Allen G. Taylor, Data Analytics & Visualization All-in-One For Dummies, 1st Edition, Wiley (For Dummies), 2024. ISBN: 978-1-394-24409-6.
3) Laura Igual and Santi Seguí, Introduction to Data Science: A Python Approach to Concepts, Techniques and Applications, 2nd Edition, Springer, 2024. ISBN: 978-3-031-48955-6.

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/110106072
- https://onlinecourses.nptel.ac.in/noc26_cs86/preview
- https://www.youtube.com/playlist?list=PLrpK1inhO61UK4E_DzNtSq-zDY36NJMuP
- https://www.youtube.com/watch?v=TPMlZxRRaBQ
- https://www.youtube.com/watch?v=aHaOIvR00So
- https://www.tableau.com/learn/training

Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning

- Data Quality Analysis: Identify and resolve data-quality issues in a real-world dataset.
- Statistical Decision Making: Apply suitable statistical techniques to a real-world problem.
- Time-Series Analysis: Identify trend and seasonality and apply moving averages to real-world data.
- Market Basket Analysis: Discover associations using support, confidence and lift.
- Case-Based Analytics: Analyze a real-world business/social problem and identify suitable analytics techniques.
- Visualization Selection Activity: Select appropriate charts for different data types and analytical objectives.

****

AGENTIC AI LAB			
Course Code	**26MCDSL28**	**Credits**	**1.5**
L:T:P:S	**0:0:1.5:0**	**CIE Marks**	**50**
TLP Contact Hours / Sem	**42**	**SEE Marks**	**50**
TW & SL / Sem	**03**	**Total Marks**	**100**
Total Hours /Sem	**45**	**Exam Hours**	**03**

Course outcomes:
At the end of the course, the student will be able to:

26MCDSL28.1	Apply prompt engineering techniques to interact effectively with Large Language Models (LLMs).
26MCDSL28.2	Develop AI assistants using conversational memory, document processing, and retrieval techniques.
26MCDSL28.3	Implement AI agents with tool calling, external knowledge integration, and content generation capabilities.
26MCDSL28.4	Analyze AI systems for code assistance, task planning, and multi-agent collaboration.
26MCDSL28.5	Investigate AI applications by applying safety techniques and guardrails for responsible AI.

Pgm. No.	List of Programs	Hours	COs
	Prerequisite Programs		
	Prerequisites: Basic knowledge of Python programming, Artificial Intelligence concepts, Object-Oriented Programming, APIs, and Python development tools.	3	NA
	PART-A		
1	Prompt Engineering: • Write a Python program to interact with a Large Language Model (LLM) and generate responses to user queries. • Compare the responses obtained using different prompting strategies (Zero-shot, Few-shot, and Role-based prompts).	3	26MCDSL28.1
2	Conversational Memory: • Develop an AI assistant that maintains conversation history. • Extend the assistant to answer follow-up questions using previous interactions.	3	26MCDSL28.2
3	Text Processing: • Develop an AI assistant that summarizes a given document. • Modify the assistant to extract key points and action items from the document.	3	26MCDSL28.2
4	Retrieval • Develop an AI assistant that retrieves information from a PDF document. • Compare responses with and without Retrieval-Augmented Generation (RAG).	3	26MCDSL28.2
5	Tool Calling: • Develop an AI assistant capable of invoking Python functions (calculator, unit conversion, etc.). • Extend the assistant to automatically select the appropriate function based on user queries.	3	26MCDSL28.3
6	External Knowledge: • Develop an AI assistant that searches Wikipedia or the Web for factual information.	3	26MCDSL28.3

	• Display the retrieved source along with the generated response.		
PART-B			
7	Content Generation: • Develop an AI assistant to generate professional emails from user instructions. • Extend the assistant to rewrite the email in different tones (formal, polite, concise).	3	26MCDSL28.3
8	Code Assistant: • Develop an AI programming assistant to explain Python programs. • Modify the assistant to detect and suggest corrections for simple programming errors.	3	26MCDSL28.4
9	Task planning: • Develop an AI agent that plans a sequence of tasks to achieve a given objective. • Display the generated execution plan before producing the final response. Planning	3	26MCDSL28.4
10	Multi-Agent Collaboration: • Develop two collaborating AI agents (Research Agent and Report Agent). • Compare the output generated by a single agent and a multi-agent system.	3	26MCDSL28.4
11	AI Safety & Responsible AI: • Develop an AI assistant that validates user prompts against unsafe or malicious instructions. • Implement basic guardrails to prevent unsafe responses	3	26MCDSL28.5
12	Problem Based Learning: • Develop an Agentic AI application such as a Student Learning Assistant, Research Assistant, Resume Analyzer, FAQ Assistant, Smart Document Assistant, or Travel Planner integrating at least three Agentic AI concepts.	3	26MCDSL28.1 To 26MCDSL28.5

PART-C

Beyond Syllabus Virtual Lab Content (3 Hours)

(To be done during Lab but not to be included for CIE or SEE)

- To demonstrate Uniform Cost Search algorithm on a simple graph setting.
  https://ai2-iiith.vlabs.ac.in/exp/uniform-cost-search/
- To understand the Iterative Deepening Depth-First Search algorithm and its iterative nature
  https://ai2-iiith.vlabs.ac.in/exp/iterative-deepening-dfs/
- To illustrate the Minimax Search algorithm in strategy games, focusing on its decision-making process.
  https://ai1-iiith.vlabs.ac.in/exp/minimax-search/
- To demonstrate the Hill Climbing algorithm applied on a simple N queens problem.
  https://ai2-iiith.vlabs.ac.in/exp/hill-climbing-search/

CIE Assessment Pattern (50 Marks – Lab)

RBT Levels		Test (s)	Weekly Assessment
		30	20
L1	Remember	-	-
L2	Understand	-	-
L3	Apply	25	10
L4	Analyze	25	10
L5	Evaluate	-	-
L6	Create	-	-

SEE Assessment Pattern (50 Marks – Lab)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	-
L2	Understand	-
L3	Apply	25
L4	Analyze	25
L5	Evaluate	-
L6	Create	-

Suggested Learning Resources:

Text Books:

1) Chip Huyen, *AI Engineering: Building Applications with Foundation Models*, O'Reilly Media, 1st Edition, 2025, ISBN: 978-1-098-16630-4.
2) Nathan George, *Prompt Engineering for Generative AI*, O'Reilly Media, 1st Edition, 2024, ISBN: 978-1-098-15615-2.
3) Stuart Russell and Peter Norvig, *Artificial Intelligence: A Modern Approach*, Pearson Education, 4th Edition, 2021, ISBN: 978-0-13-461099-3.

Reference Books:

1) Tom Taulli, *Generative AI: How ChatGPT and Other AI Tools Will Revolutionize Business*, Apress, 1st Edition, 2023, ISBN: 978-1-4842-9892-3.
2) Nils J. Nilsson, *Artificial Intelligence: A New Synthesis*, Morgan Kaufmann, 1st Edition, 1998, ISBN: 978-1-55860-467-4.
3) Al Sweigart, *Automate the Boring Stuff with Python*, No Starch Press, 2nd Edition, 2019, ISBN: 978-1-59327-992-9.

****

DATA SCIENCE AND VISUALIZATION LAB			
Course Code	**26MCDSL29**	**Credits**	**1.5**
L:T:P:S	**0:0:1.5:0**	**CIE Marks**	**50**
TLP Contact Hours / Sem	**42**	**SEE Marks**	**50**
TW & SL / Sem	**03**	**Total Marks**	**100**
Total Hours /Sem	**45**	**Exam Hours**	**03**

Course outcomes:
At the end of the course, the student will be able to:

26MCDSL29.1	Apply data preprocessing techniques to identify, handle and prepare data for analysis.
26MCDSL29.2	Apply Python programming and statistical techniques to perform descriptive, probabilistic, and inferential data analysis.
26MCDSL29.3	Apply statistical techniques, including correlation, dimensionality reduction, regression, and time series analysis, to analyze datasets and derive meaningful insights.
26MCDSL29.4	Apply data mining techniques to detect outliers and extract frequent patterns and association rules from datasets.
26MCDSL29.5	Develop interactive Tableau visualizations and dashboards using clustering, forecasting, and data storytelling techniques to explore, analyze, interpret, and communicate data-driven insights.

Pgm. No.	List of Programs	Hours	COs
	Prerequisite Programs / Demo		
	• Basics of Python • Installation of Tableau and connection to the datasets.	3	NA
	PART-A		
1	• Write a Python program to identify data types, data nature, and levels of measurement for the given dataset. • Write a Python program to identify missing values, duplicate records, and data-quality issues.	3	26MCDSL29.1
2	• Write a Python program to calculate the mean, median, mode, standard deviation, variance and covariance for the given dataset. • Write a Python program to generate and visualize Binomial, Poisson and Normal probability distributions.	3	26MCDSL29.2
3	• Write a Python program to apply different sampling techniques to a given dataset and display the selected samples. • Write a Python program to perform Z-test, t-test and Chi Square test on a given dataset and interpret the statistical results	3	26MCDSL29.2
4	• Write a Python program to calculate and visualize the Pearson correlation coefficient between numerical variables in a given dataset. • Write a Python program to perform regression analysis on a given dataset and display the predicted values and model performance.	3	26MCDSL29.3
5	• Write a Python program to analyze a given time-series dataset, visualize the trend, and identify patterns in the data. • Write a Python program to perform Principal Component Analysis (PCA) for dimensionality reduction on a given dataset.	3	26MCDSL29.3
6	• Write a Python program to identify and remove outliers from a dataset using the Interquartile Range (IQR) method and Z-	3	26MCDSL29.4

	score method. • Write a Python program to implement the Apriori algorithm.		
PART-B			
7	• Write a procedure to create and visualize bar charts and pie charts using Tableau for a given dataset. • Write a procedure to create and visualize line charts and histograms using Tableau for a given dataset.	3	26MCDSL29.5
8	• Write a procedure to create and visualize box plots and scatter plots using Tableau to analyze data distributions, outliers, and relationships between variables. • Write a procedure to create and visualize heat maps using Tableau to identify patterns and relationships among categorical and numerical variables.	3	26MCDSL29.5
9	• Write a procedure to develop a Tableau visualization to analyze sales and profit performance across categories, regions, and time. • Write a procedure to develop an interactive Tableau dashboard to analyze sales, profit, quantity sold, and profitability trends using filters, charts, and calculated fields.	3	26MCDSL29.5
10	• Write a procedure to perform clustering and forecasting in Tableau to identify customer segments and predict future sales trends using historical data. • Write a procedure to develop a Tableau visualization using trend lines and reference lines to analyze relationships, trends, and variations in historical sales data.	3	26MCDSL29.5
11	• Write a procedure to create an interactive Tableau dashboard using filters and calculated fields for data analysis. • Write a procedure to create an interactive Tableau dashboard using parameters and interactive visualizations for data exploration.	3	26MCDSL29.5
12	• Write a procedure to develop a Tableau data story using multiple worksheets to communicate insights from a real-world dataset. • Write a procedure to develop and present a Tableau data story to analyze trends, patterns, and key findings from a real-world dataset.	3	26MCDSL29.5

PART-C

Beyond Syllabus Virtual Lab Content (3 Hours)

(To be done during Lab but not to be included for CIE or SEE)

- To investigate the probability distributions of discrete and continuous random variables.
  https://ps-iitd.vlabs.ac.in/exp/discrete-continuous-random/
- To describe the basic statistical features of the data and summaries about the sample and the measures together with the graphical analysis.
  https://ps-iitd.vlabs.ac.in/exp/descriptive-statistics/
- To introduce students to essential data pre-processing techniques that prepare raw data for effective analysis and interpretation.
  https://ids-amrt.vlabs.ac.in/exp/data-preprocessing/
- To introduce students to Tableau Public and explore interactive data visualizations, dashboards, and visual analytics created using different datasets.
  https://public.tableau.com/app/discover

CIE Assessment Pattern (50 Marks – Lab)

RBT Levels		Marks Distribution	
		Test (s)	Weekly Assessment
		30	20
L1	Remember	-	-
L2	Understand	-	-
L3	Apply	20	10
L4	Analyze	10	10
L5	Evaluate	-	-
L6	Create	-	-

SEE Assessment Pattern (50 Marks – Lab)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	-
L2	Understand	-
L3	Apply	25
L4	Analyze	25
L5	Evaluate	-
L6	Create	-

Suggested Learning Resources

Reference Books:

1) Jeffrey D. Camm, James J. Cochran, Michael J. Fry and Jeffrey W. Ohlmann, Business Analytics, 5thEdition, Cengage Learning, 2024. ISBN: 978-0-357-90220-2.
2) Michael Sullivan III, Statistics: Informed Decisions Using Data, 7th Edition, Pearson, 2024. ISBN: 978-0-13-825333-2.
3) Jiawei Han, Jian Pei and Hanghang Tong, Data Mining: Concepts and Techniques, 4th Edition, MorganKaufmann (Elsevier), 2022. ISBN: 978-0-12-811760-6.
4) Joshua N. Milligan, Learning Tableau 2022, 5th Edition, Packt Publishing, 2022. ISBN: 978-1-80107-232-8.
5) Wes McKinney, Python for Data Analysis: Data Wrangling with pandas, NumPy, and Jupyter, 3rd Edition, O&39;Reilly Media, 2022. ISBN: 978-1-098-10403-0.
6) Jack A. Hyman, Luca Massaron, Paul McFedries, John Paul Mueller, Jonathan Reichental, Joseph Schmuller, Alan R. Simon and Allen G. Taylor, Data Analytics & Visualization All-in-One for Dummies, 1st Edition, Wiley (For Dummies), 2024. ISBN: 978-1-394-24409-6.
7) Laura Igual and Santi Seguí, Introduction to Data Science: A Python Approach to Concepts, Techniques and Applications, 2nd Edition, Springer, 2024. ISBN: 978-3-031-48955-6.

****

ENTERPRISE APPLICATION DEVELOPMENT SPECIALIZATION	
Course Code	**Course Name**
26MCEA26	ENTERPRISE APPLICATION TESTING AND QUALITY ASSURANCE
26MCEA27	AI FOR ENTERPRISE APPLICATIONS
26MCEAL28	SOFTWARE TESTING AND QUALITY ASSURANCE LAB
26MCEAL29	AI FOR ENTERPRISE APPLICATIONS LAB

ENTERPRISE APPLICATION TESTING AND QUALITY ASSURANCE			
Course Code	**26MCEA26**	**Credits**	**03**
L:T:P:S	**3:0:0:0**	**CIE Marks**	**50**
TLP Contact Hours / Sem	**42**	**SEE Marks**	**50**
TW & SL / Sem	**48**	**Total Marks**	**100**
Total Hours /Sem	**90**	**Exam Hours**	**03**

Course outcomes:
At the end of the course, the student will be able to:

26MCEA26.1	Explain the concepts, evolution, technologies, implementation approaches, and functional modules of Enterprise Resource Planning (ERP).
26MCEA26.2	Apply appropriate testing types, levels, approaches, and techniques for testing and rolling out enterprise applications.
26MCEA26.3	Explain software quality concepts, software quality factors, and the fundamentals and objectives of Software Quality Assurance (SQA).
26MCEA26.4	Apply software quality processes, configuration management, quality metrics, and quality standards to support software quality management.
26MCEA26.5	Develop automated test scripts using Selenium WebDriver and TestNG/JUnit.

MODULE-1	**ERP OVERVIEW, TECHNOLOGIES AND FUNCTIONAL MODULES**	**26MCEA26.1**	**8 Hours**

ERP Overview: Definition, Need and Evolution of ERP, Characteristics and Benefits of ERP, ERP Vs Traditional Information Systems, ERP as an Integrated Enterprise-Wide Information System.
Technologies Related To ERP: Electronic Data Interchange (EDI), Enterprise Application Integration (EAI), Middleware, Data Warehousing, Data Mining, Online Analytical Processing (OLAP), Product Life Cycle Management (PLM), Business Intelligence and Analytics, ERP Implementation: Life Cycle, Methodologies and Strategy. Overview of ERP Functional Modules: Financial Management, Supply Chain Management (SCM), Customer Relationship Management (CRM), And Human Capital Management (HCM)

Case Study	A college wants to implement an ERP system to integrate Finance, HR, Procurement, and Student Services. The existing systems work independently, causing data duplication and delays. Identify suitable ERP modules and explain how ERP technologies can improve integration and decision-making.
Text Book	Text Book 1: 1, 2, 20, 21, 23, 28, 33

MODULE-2	**TESTING AND ROLLING OUT ENTERPRISE APPLICATIONS**	**26MCEA26.2**	**8 Hours**

Testing Enterprise Applications: Types and Methods of Testing an Enterprise Application, Testing Levels and Approaches, Enterprise Application Environments, Integration Testing, System Testing, Performance Testing, Penetration Testing, Usability Testing, Globalization Testing and Interface Testing, User Acceptance Testing, Rolling Out an Enterprise Application.

Case Study	A retail company develops an online shopping application for managing products, orders, and customer details. Before launching the application, it needs to be tested properly. Identify the different types of testing that can be performed and explain their purpose.
Text Book	Text Book 2: 5

MODULE-3	**FUNDAMENTALS OF SOFTWARE QUALITY ASSURANCE**	**26MCEA26.3**	**8 Hours**

Software, Software Errors, Faults and Failures, Classification of the Causes of Software Errors, Definition of Software Quality, Software Quality Assurance, Software Quality Control, Software Quality Assurance And Software Engineering, Objectives Of SQA Activities, Software Quality Factors: The Need for Comprehensive Software Quality Requirements, Classification of Software Requirements into Software Quality Factors, Product Operation Software Quality Factors, Product Revision Software Quality Factors, Product Transition Software Quality Factors, Alternative Models Of Software Quality Factors, Who is Interested in the Definition of Quality Requirements.

Case Study	A company develops a mobile banking application, but users report errors and frequent failures. The development team wants to improve the software quality before release. Identify the possible causes of software errors and explain how SQA and software quality factors can help improve the application.

Text Book	Text Book 3: 2, 3		
MODULE-4	**SOFTWARE QUALITY PROCESSES, METRICS AND STANDARDS**	**26MCEA26.4**	**9 Hours**
SQA System and Architecture – Components of SQA System, SQA Activities During Software Project Life Cycle, Verification and Validation, Software Configuration Management – Configuration Items, Version Control and Change Control, Configuration Management Audits, Software Quality Metrics – Process and Product Metrics, Limitations of Software Metrics, Standards: Need for Software Quality Standards, Software Quality Management Standards, ISO 9001, ISO/IEC 9000-3, CMM/CMMI.			
Applications	Applying CMMI for Software Process Improvement – Identify the quality processes, configuration management practices, software metrics, and process improvements required for a software organization to achieve a higher CMMI maturity level.		
Text Book	Text Book 3: 4, 7, 8, 18, 21, 23		
MODULE-5	**TEST AUTOMATION USING SELENIUM**	**26MCEA26.5**	**9 Hours**
Need for Test Automation in Application Testing, Introduction to Selenium: Selenium IDE, Selenium WebDriver, and Selenium Grid — Architecture and Components, WebDriver Fundamentals: Locators (ID, Name, Class, Xpath, CSS Selectors), Handling Web Elements, Forms, and Browser Events, Handling Waits and Synchronization. Building Automated Test Scripts: Integrating Selenium WebDriver with a Test Framework Such as TestNG/JUnit for Assertions.			
Case Study	A company wants to automate testing of its online shopping website using Selenium WebDriver. Identify suitable locators and explain how waits and TestNG assertions can be used to test the application.		
Text Book	Text Book 4: 1, 2, 3, 6, 8		

CIE Assessment Pattern (50 Marks – Theory)

RBT Levels		Marks Distribution		
		Test (s)	AAT1	AAT2
		25	15	10
L1	Remember	-	-	-
L2	Understand	10	5	5
L3	Apply	5	5	5
L4	Analyze	10	5	-
L5	Evaluate	-	-	-
L6	Create	-	-	-

SEE Assessment Pattern (50 Marks – Theory)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	-
L2	Understand	20
L3	Apply	10
L4	Analyze	20
L5	Evaluate	-
L6	Create	-

Suggested Learning Resources:

Text Books:

1) Rajesh Ray, Enterprise Resource Planning: Text and Cases, Tata McGraw Hill Education Private Limited, New Delhi, 2010. ISBN: 978-0-07-070088-8.
2) Anubhav Pradhan, Satheesha B. Nanjappa, Senthil Nallasamy, Veerakumar E., *"Raising Enterprise Applications: A Software Engineering Perspective,"* Wiley India Pvt. Ltd., 2010.
3) Daniel Galin, *"Software Quality Assurance: From Theory to Implementation,"* Pearson/Addison-Wesley, 1st Edition, 2004. ISBN: 0-201-70945-7.
4) Boni Garcia, Hands-On Selenium WebDriver with Java: A Deep Dive into the Development of End-to-End Tests, Packt Publishing, 2022, ISBN: 9781098110000.

Reference Books:

1) Alexis Leon, Enterprise Resource Planning, 4th Edition, McGraw Hill Education, 2020, ISBN:

9789353167837.

2) Abu Sayed Mahfuz, Software Quality Assurance: Integrating Testing, Security, and Audit, CRC Press, 2021, ISBN: 9780367567972.
3) Rahul Shetty, Selenium WebDriver with Java - Basics to Advanced and Frameworks, 2023, Packt Publishing, ISBN: 9781789132908.

Web links and Video Lectures (e-Resources):

- https://www.nptel.ac.in/courses/112107238
- https://www.youtube.com/playlist?list=PLL34mf651faPB-LyEP0-a7Avp_RHO0Lsm
- https://www.youtube.com/watch?v=mDC8ZSKTWKc

Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning

- Expert talk on topics such as Industry Perspectives on ERP Implementation, Enterprise Application Testing, and Software Quality Practices.
- Group activity: Compare different ERP implementation and testing strategies and present the findings.

****

AI FOR ENTERPRISE APPLICATIONS			
Course Code	**26MCEA27**	**Credits**	**03**
L:T:P	**3:0:0:0**	**CIE Marks**	**50**
TLP Contact Hours / Sem	**42**	**SEE Marks**	**50**
TW & SL / Sem	**48**	**Total Marks**	**100**
Total Hours /Sem	**90**	**Exam Hours**	**03**

Course outcomes:
At the end of the course, the student will be able to:

26MCEA27.1	Explain the fundamental concepts of Artificial Intelligence and its role in enterprise applications.
26MCEA27.2	Apply machine learning techniques for solving enterprise-level business problems.
26MCEA27.3	Analyze enterprise data using appropriate data processing, predictive and classification techniques.
26MCEA27.4	Apply Natural Language Processing and Generative AI techniques for developing intelligent enterprise applications.
26MCEA27.5	Evaluate AI solutions with respect to deployment, ethics, security, governance and responsible use in enterprise environments.

MODULE-1	**INTRODUCTION TO ARTIFICIAL INTELLIGENCE AND ENTERPRISE AI**	**26MCEA27.1**	**8 Hours**

Introduction to Artificial Intelligence, Foundations and History of Artificial Intelligence, State of the Art, Risks and Benefits of AI, Intelligent Agents, Agents and Environments, Rationality, Nature of Environments, Structure of Agents. Introduction to Enterprise Applications, Role of AI in Enterprises, AI-Driven Digital Transformation, Enterprise Data and AI, AI Applications in Customer Relationship Management, Enterprise Resource Planning, Supply Chain Management, Finance, Healthcare and Human Resource Management.

Case Study	Analyze how AI is used in enterprise CRM systems to improve customer experience through chatbots
Text Book	Text Book 1: Chapter 1, 2

MODULE-2	**MACHINE LEARNING FOR ENTERPRISE APPLICATIONS**	**26MCEA27.2**	**8 Hours**

Introduction to Machine Learning, Learning from Examples, Types of Learning, Supervised Learning, Unsupervised Learning and Reinforcement Learning. Decision Tree Learning, Regression and Classification Concepts, Probabilistic Models, Learning Probabilistic Models, Deep Learning, Neural Networks and Reinforcement Learning. Applications of Machine Learning in Customer Analytics, Sales Forecasting, Fraud Detection and Business Decision Making.

Self-Study	Study how Machine Learning techniques are used in enterprises for sales forecasting.
Text Book	Text Book 1: Chapter 19, 20

MODULE-3	**DATA ANALYTICS AND PREDICTIVE INTELLIGENCE**	**26MCEA27.3**	**8 Hours**

Enterprise Data Analytics, Data Preparation, Data Representation, Learning from Data, Predictive Modelling, Classification, Regression and Probabilistic Prediction. Model Training and Evaluation, Performance Measures, Clustering, Pattern Discovery, Anomaly Detection and Applications of Predictive Intelligence in Enterprise Decision Making.

Application	Use enterprise data analytics and predictive modelling to identify customers who are likely to stop using a company's products or services.
Text Book	Text Book 1: Chapter 21, 22

MODULE-4	**NATURAL LANGUAGE PROCESSING AND GENERATIVE AI FOR ENTERPRISES**	**26MCEA27.4**	**9 Hours**

Natural Language Processing, Language Models, Text Processing and Natural Language Understanding, Deep Learning for Natural Language Processing, Attention Mechanisms and Transformer Architecture. Introduction to Generative AI, Large Language Models, Prompt Engineering, Enterprise Chatbots, Document Summarization, Question Answering, Retrieval-Augmented Generation and Enterprise Knowledge Assistants.

Case Study	Designing prompts and enterprise knowledge assistants using Generative AI.

Text Book	Text Book 1: Chapter 23, 24, Text Book 2: Chapter 16		
MODULE-5	**ENTERPRISE AI DEPLOYMENT, GOVERNANCE AND RESPONSIBLE AI**	**26MCEA27.5**	**9 Hours**
AI Application Lifecycle, AI Model Deployment, Model Serving, Model Monitoring and Maintenance, Scalable AI Systems and Enterprise AI Integration. Responsible AI, AI Ethics, Fairness, Privacy, Security, AI Governance and Risk Management. Challenges and Future Trends in Enterprise AI.			
Case Study	Conducting case studies on AI ethics, bias, privacy and governance.		
Text Book	Text Book 1: Chapter 26, 27, Text Book 2: Chapter 19		

CIE Assessment Pattern (50 Marks – Theory)

RBT Levels		Marks Distribution		
		Test (s)	AAT1	AAT2
		25	15	10
L1	Remember	-	-	-
L2	Understand	10	5	-
L3	Apply	10	5	5
L4	Analyze	5	5	5
L5	Evaluate	-	-	-
L6	Create	-	-	-

SEE Assessment Pattern (50 Marks – Theory)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	-
L2	Understand	20
L3	Apply	20
L4	Analyze	10
L5	Evaluate	-
L6	Create	-

Suggested Learning Resources:

Text Book:

1) Stuart Russell and Peter Norvig, *Artificial Intelligence: A Modern Approach*, 4th Edition, Pearson Education, 2022, ISBN: 9789356063570.
2) Aurélien Géron, *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow*, 3rd Edition, O'Reilly Media, Inc., 2022, ISBN: 9781098125967.

Reference Books:

1) Tom M. Mitchell, Machine Learning, McGraw-Hill Education, ISBN-13: 9780070428072.
2) Ethem Alpaydin, Introduction to Machine Learning, 4th Edition, MIT Press, 2020, ISBN-13: 9780262043793.
3) Steven Bird, Ewan Klein and Edward Loper, Natural Language Processing with Python, 1st Edition, O'Reilly Media, Inc., 2009, ISBN-13: 9780596516499.
4) Chip Huyen, Designing Machine Learning Systems: An Iterative Process for Production-Ready Applications, 1st Edition, O'Reilly Media, Inc., 2022, ISBN-13: 9781098107956.

Web links and Video Lectures (e-Resources)

- https://www.nptel.ac.in/courses/106108705
- https://www.nptel.ac.in/courses/106103843
- https://www.coursera.org/learn/generative-ai-for-everyone

Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning

- Examining the characteristics and challenges of Big Data using real-world datasets.
- Comparing HDFS, MapReduce and Spark based on their data processing approaches.

****

SOFTWARE TESTING AND QUALITY ASSURANCE LAB			
Course Code	**26MCEAL28**	**Credits**	**1.5**
L:T:P:S	**0:0:1.5:0**	**CIE Marks**	**50**
TLP Contact Hours / Sem	**42**	**SEE Marks**	**50**
TW & SL / Sem	**03**	**Total Marks**	**100**
Total Hours /Sem	**45**	**Exam Hours**	**03**

Course outcomes:
At the end of the course, the student will be able to:

26MCEAL28.1	Design test cases using software testing techniques.
26MCEAL28.2	Implement different levels and types of software testing.
26MCEAL28.3	Develop automated test cases using Selenium IDE for web application testing.
26MCEAL28.4	Develop Selenium WebDriver scripts to automate and validate web application functionalities.
26MCEAL28.5	Implement automated testing using Selenium WebDriver with JUnit and TestNG frameworks.

Pgm. No.	List of Programs	Hours	Cos
	Prerequisite Programs / Demo		
	Installation of Selenium and Web Drivers.	**3**	**NA**
	PART-A		
1	• Write a java program to implement a login system that accepts correct combinations of username and password. Design a decision table to test combinations (correct, wrong username, wrong password, both wrong). • Write a Java program that accepts a valid date (day, month, year) and displays the next date. The program should account for different month lengths and leap years. Use Boundary Value Analysis (BVA) to design test cases.	3	26MCEAL28.1
2	• Write a Java program to calculate the commission for a salesperson based on the following rules: *If sales amount is less than Rs. 5000 No commission* *If sales amount is between Rs. 10001 and 20000 → 10% commission* *sales amount is more than Rs. 20000 →15% commission.* Use Boundary Value Analysis (BVA) to design and execute test cases. • Write a Java program that takes an input score (0 to 100) and prints the corresponding grade using the following criteria: 90-100→ Grade A 75-89 → Grade B 50-74→ Grade C 0→49 Grade D Any value outside 0-100→ Invalid input. Use Equivalence Partitioning to design and test different input classes (valid and invalid)	3	26MCEAL28.1
3	• Write a Java program to calculate the factorial of a number and demonstrate how unit testing is used to verify the output for different input values. Test cases must handle valid and invalid inputs (e.g., negative numbers). • Create a calculator program with add() and multiply() methods. Show how integration testing is applied by verifying the combined behavior of both methods.	3	26MCEAL28.2

4	• Develop a basic shopping cart simulation. The program should place an order only if there are items in the cart and the payment is successful. Perform system testing with different scenarios. • Write a simple program to simulate alpha testing feedback. Include a message indicating this is an internal product test.	3	26MCEAL28.2
5	• Write a Java program that mimics a beta test by displaying a placeholder message for feedback collected from real users. • Write a Java program that calculates the execution time for a dummy loop to simulate performance testing.	3	26MCEAL28.2
6	• Write a Selenium IDE test script to automate login functionality. The script should open the login page, enter valid credentials, click the login button, and verify that the welcome message is displayed. • Create a Selenium IDE test case to validate the search functionality of a website. The script should enter a keyword in the search box, click the search button, and verify that the results page displays a relevant heading.	3	26MCEAL28.3
PART-B			
7	• Design a Selenium IDE test case to test menu navigation. The script should click on the 'Products' menu link from the home page and verify the page title after navigation. • Write a Selenium IDE test case to automate the submission of a 'Contact' form. The script should enter the name, email, and message, click the submit button, and confirm the appearance of a success message.	3	26MCEAL28.3
8	• Develop a Java program using Selenium WebDriver to automate the opening of the ERP application, and verify that the dashboard is displayed successfully. • Develop a Java program using Selenium WebDriver to open the ERP application, retrieve and display the page title and current URL, and verify whether the page title and URL are valid.	3	26MCEAL28.4
9	• Develop a Java program using Selenium WebDriver to open the ERP website, identify all the links available on the page, and display the text of each link. • Develop a Java program using Selenium WebDriver to open the ERP website, locate the search field, enter a search keyword, perform the search operation, and verify that the search results are displayed successfully.	3	26MCEAL28.4
10	• Develop a Java Selenium WebDriver and JUnit program to log in to an ERP application using valid credentials, search for an existing customer, and verify that the expected customer record is displayed. • Develop a Java Selenium WebDriver and JUnit program to log in to an ERP application, navigate to the product section, search for an existing product, and verify that the expected product is displayed.	3	26MCEAL28.4
11	• Write a Java program using Selenium WebDriver and TestNG to launch Google and verify the title using @Test and assertions. • Develop a Selenium WebDriver Java script using TestNG @Parameters annotation to test a login page with different user credentials.	3	26MCEAL28.5

12	• Write a Java program using TestNG to demonstrate the concept of grouping test cases. • Design a data-driven login test in Selenium WebDriver using Java and TestNG.	3	26MCEAL28.5

PART-C

Beyond Syllabus Virtual Lab Content (3 Hours)

(To be done during Lab but not to be included for CIE or SEE)

- To understand and implement unit testing techniques for verifying functional requirements, identify defects through test cases, analyze test results, and modify programs to handle valid and invalid inputs. Students to complete the relevant learning objectives using the Software Engineering Virtual Lab. Link: https://vlabs.iitkgp.ac.in/sevl/Exp10/Exercises/test_suit.html
- To understand and apply white-box testing techniques by constructing Control Flow Graphs, determining Cyclomatic Complexity using McCabe's method, identifying independent paths, and evaluating the structural complexity of a program. Students to complete the relevant learning objectives using the Software Engineering Virtual Lab.
  Link: https://vlabs.iitkgp.ac.in/sevl/Exp9/Exercises/cfg.html
- To understand and implement Data Flow Diagrams (DFDs) for representing the flow of information within a system, identify processes, data stores, external entities, and data flows, and develop DFDs for analyzing and modeling software system requirements. Students to complete the relevant learning objectives using the Software Engineering Virtual Lab.
  Link: https://vlabs.iitkgp.ac.in/sevl/Exp8/Exercises/dfd.html
- To understand and implement UML Class and Sequence Diagrams for modeling the structural and behavioral aspects of software systems, identify classes, objects, relationships, interactions, and message sequences, and develop appropriate diagrams for software system analysis and design. Students to complete the relevant learning objectives using the Software Engineering Virtual Lab. Link: https://vlabs.iitkgp.ac.in/sevl/Exp7/Exercises/class_seq.html

CIE Assessment Pattern (50 Marks – Hands On)

RBT Levels		Test (s)	Weekly Assessment
		30	20
L1	Remember	-	-
L2	Understand	-	5
L3	Apply	20	10
L4	Analyze	10	5
L5	Evaluate	-	-
L6	Create	-	-

SEE Assessment Pattern (50 Marks – Practical)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	-
L2	Understand	-
L3	Apply	25
L4	Analyze	25
L5	Evaluate	-
L6	Create	-

Suggested Learning Resources:

Text Books:

1) Rahul Shetty, Selenium WebDriver with Java - Basics to Advanced and Frameworks, 2023, Packt Publishing, ISBN: 9781789132908.
2) Pallavi Sharma, Selenium with Java – A Beginner's Guide, BPB Publications, 2022, ISBN: 978-9391392680.

3) Ilene Burnstein, Practical Software Testing: A Process-Oriented Approach, 1st Edition, Springer-Verlag New York, 2003, ISBN: 978-0-387-95131-7.

Reference Books:

1) Srinivasan Desikan and Gopalaswamy Ramesh, Software Testing: Principles and Practices, Pearson Education India, 2007, ISBN: 978-8177581218.

2) Roger S. Pressman, Bruce R. Maxim, Software Engineering – A Practitioner's Approach, Ninth Edition, McGraw-Hill International Edition, 2023, ISBN: 978-9355325044.

- Web links and Video Lectures (e-Resources):
- https://www.selenium.dev/documentation/
- https://www.softwaretestinghelp.com/selenium-tutorial-1/
- https://onlinecourses.nptel.ac.in/noc25_cs66/preview
- https://www.udemy.com/courses/development/software-testing/
- https://www.geeksforgeeks.org/software-testing/database-testing-using-java-selenium-and-testng/

Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning

- Given a small java snippet with bugs, identify the bugs, classify them as error / defect / failure, and map to the SDLC and STLC stages.
- Given a scenario for ATM PIN validation or mobile number registration, test cases can be created using Boundary Value Analysis, Equivalence Partitioning, and Decision Tables.
- Expert Talk on Industry expectations and career pathways in QA/Testing.

****

AI FOR ENTERPRISE APPLICATIONS LAB			
Course Code	**26MCEAL29**	**Credits**	**1.5**
L:T:P:S	**0:0:1.5:0**	**CIE Marks**	**50**
TLP Contact Hours / Sem	**42**	**SEE Marks**	**50**
TW & SL / Sem	**03**	**Total Marks**	**100**
Total Hours /Sem	**45**	**Exam Hours**	**03**

Course outcomes:
At the end of the course, the student will be able to:

26MCEAL29.1	Perform exploratory data analysis and preprocessing on enterprise datasets using Python libraries.
26MCEAL29.2	Develop and evaluate supervised and unsupervised machine learning models for enterprise applications.
26MCEAL29.3	Build predictive analytics solutions for enterprise problems using appropriate machine learning techniques.
26MCEAL29.4	Develop Natural Language Processing and Generative AI applications for enterprise use cases.
26MCEAL29.5	Design and evaluate AI-based enterprise applications by considering reliability, responsible AI, and practical deployment requirements.

Pgm. No.	List of Programs	Hours	COs
	Prerequisite Programs		
	• Python Programming Basics • Python Data Structures • Data Handling and Visualization • Basic Statistical Analysis • Introduction to Machine Learning	3	NA
	PART-A		
1	Perform exploratory data analysis and visualization on an enterprise dataset to identify data characteristics, trends, and patterns.	3	26MCEAL29.1
2	Perform data preprocessing by handling missing values and duplicate records, and applying suitable data transformation techniques.	3	26MCEAL29.2
3	Implement a Decision Tree classifier for an enterprise application such as customer classification or churn prediction.	3	26MCEAL29.2
4	Implement a Naïve Bayes classifier for an enterprise application such as customer classification or spam detection.	3	26MCEAL29.2
5	Implement a regression model for predicting sales, demand, revenue, or other enterprise-related values.	3	26MCEAL29.3
6	Develop a simple recommendation system for suggesting products, services, or content.	3	26MCEAL29.3
	PART-B		
7	Implement sentiment analysis on customer reviews or feedback to identify positive, negative, or neutral opinions.	3	26MCEAL29.3, 26MCEAL29.4
8	Develop a simple AI-based chatbot for customer support or employee assistance.	3	26MCEAL29.4
9	Design and evaluate prompts for an enterprise application such as report generation, email drafting, or content generation.	3	26MCEAL29.4
10	Develop an application for summarizing enterprise documents using Generative AI techniques.	3	26MCEAL29.4
11	Develop a question-answering application using a given set of	3	26MCEAL29.5

	enterprise-related documents.		
12	Analyze the output of an AI application for reliability, bias, privacy, and other responsible AI considerations.	3	26MCEAL29.5

PART-C

Beyond Syllabus Virtual Lab Content (3 Hours)

(To be done during Lab but not to be included for CIE or SEE)

- To understand and implement different Machine Learning algorithms and analyze their performance for classification, regression, and clustering applications. Students to complete the learning objectives using the Machine Learning Virtual Lab. link: https://ml-iitr.vlabs.ac.in/exp/linear-regression.
- To understand Natural Language Processing techniques through interactive experiments and analyze language-processing tasks using computational methods. Students to complete the learning objectives using the Natural Language Processing Virtual Lab. link: https://nlp-iiith.vlabs.ac.in/exp/word-analysis.
- To understand and implement the K-Means Clustering algorithm for grouping data points based on similarity. https://ml-iitr.vlabs.ac.in/exp/kmeans-clustering.
- To understand and practice Part-of-Speech tagging using machine learning algorithms and linguistic features. https://nlp-iiith.vlabs.ac.in/exp/pos-tagger.

CIE Assessment Pattern (50 Marks – Lab)

RBT Levels		Test (s)	Weekly Assessment
		30	20
L1	Remember	-	-
L2	Understand	-	5
L3	Apply	20	10
L4	Analyze	10	5
L5	Evaluate	-	-
L6	Create	-	-

SEE Assessment Pattern (50 Marks – Lab)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	-
L2	Understand	-
L3	Apply	25
L4	Analyze	25
L5	Evaluate	-
L6	Create	-

Suggested Learning Resources:

Reference Books:

1) Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, 4th Edition, Pearson Education, 2022, ISBN-13: 9789356063570.
2) Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems, 3rd Edition, O'Reilly Media, Inc., 2022, ISBN-13: 9781098125967.
3) Steven Bird, Ewan Klein and Edward Loper, Natural Language *Processing with Python*, 1st Edition, O'Reilly Media, Inc., 2009, ISBN-13: 9780596516499.

****

APPENDICES

APPENDIX A

Outcome Based Education

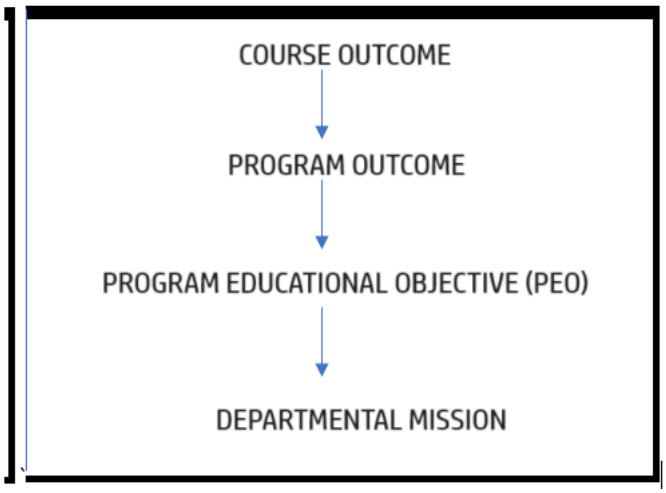
Outcome-based education (OBE) is an educational theory that bases each part of an educational system around goals (outcomes). By the end of the educational experience, each student should have achieved the goal. There is no specified style of teaching or assessment in OBE; instead, classes, opportunities, and assessments should all help students achieve the specified outcomes.

There are three educational outcomes as defined by the National Board of Accreditation: Program Educational Objectives: The Educational Objectives of the Computer Applications program are the statements that describe the expected achievements of graduate in their career and in particular, what the graduates are expected to perform and achieve during the first few years after graduation. [nbaindia.org]

Program Outcomes: What the student would demonstrate upon graduation. Graduate attributes are separately listed in Appendix B

Course Outcome: The specific outcome/s of each course/subject that is a part of the program curriculum. Each subject/course is expected to have a set of Course Outcomes.

Mapping of Outcome:



APPENDIX B

The Graduate Attributes of NBA

PO1 **(Foundation Knowledge):** Apply knowledge of mathematics, programming logic and coding fundamentals for solution architecture and problem solving.

PO2 **(Problem Analysis):** Identify, review, formulate and analyse problems for primarily focusing on customer requirements using critical thinking frameworks.

PO3 **(Development of Solutions**): Design, develop and investigate problems with an innovative approach for solutions incorporating ESG/SDG goals.

PO4 **(Modern Tool Usage):** Select, adapt and apply modern computational tools such as development of algorithms with an understanding of the limitations including human biases.

PO5 **(Individual and Teamwork):** Function and communicate effectively as an individual or a team leader in diverse and multidisciplinary groups. Use methodologies such as agile.

PO6 **(Project Management and Finance):** Use the principles of project management such as scheduling, work breakdown structure and be conversant with the principles of Finance for profitable project management.

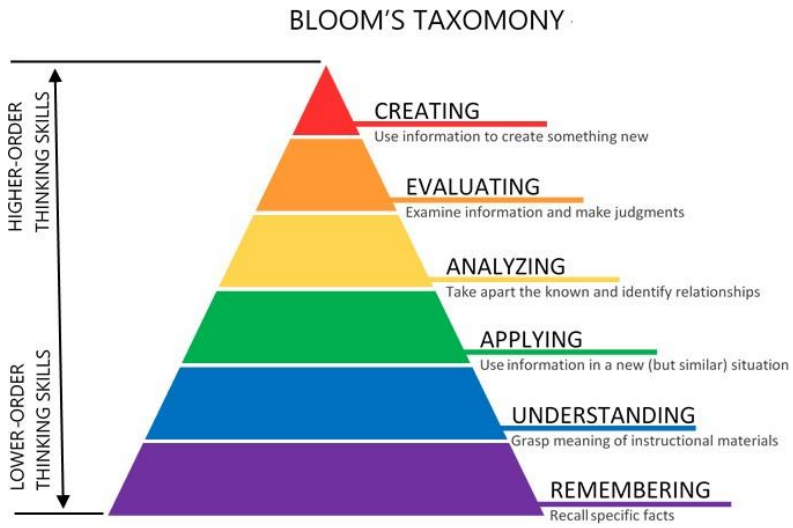
PO7 **(Ethics):** Commit to professional ethics in managing software projects with financial aspects. Learn to use new technologies for cyber security and insulate customers from malware.

PO8 **(Life-long learning):** Change management skills and the ability to learn, keep up with contemporary technologies and ways of working.

APPENDIX C

BLOOM'S TAXONOMY

Bloom's taxonomy is a classification system used to define and distinguish different levels of human cognition—i.e., thinking, learning, and understanding. Educators have typically used Bloom's taxonomy to inform or guide the development of assessments (tests and other evaluations of student learning), curriculum (units, lessons, projects, and other learning activities), and instructional methods such as questioning strategies.



www.newhorizonindia.edu

Ring Road, Bellandur Post, Near Marathahalli,
Bengaluru, Karnataka 560103, India.

Follow us

