Bharatiya Vidya Bhavan's
Sardar Patel Institute of Technology
(Empowered Autonomous Institute Affiliated to University of Mumbai)
[Knowledge is Nectar]
[Department of Computer Science and Engineering (Master of Computer Applications)]

Bharatiya Vidya Bhavan's
Sardar Patel Institute of Technology

(Autonomous Institute Affiliated to University of Mumbai)

Master of Computer Applications

Effective from Academic Year 2026-2027

Batch 2026 - 2028

Board of Studies Approval : 07/07/2026

Academic Council Approval :

Sd/-	Sd/-	Sd/-
Dr. Dhananjay Kalbande **HOD, CSE-MCA**	**Dr. Reena Sonkusare** **Dean Academics**	**Dr. B.N. haudhari** **Principal**

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MCA PROGRAM AT SPIT: 2026 ITERATION

Salient Features

- 80 Credits Education Model for Computer/IT Graduates and Non-Computer/IT Graduates.
- A strong program core of 6 courses, 3 baskets of Thread Electives, 8 Program Electives, 9 skilled-based courses to ensure breadth and depth in a chosen domain of studies.
- Credit-based 6-Month Industry Internship.
- One year Major Project.
- Summer Term for Interview Preparation.
- Aggressive model of "Learning by Doing".
- Open courses like Finance, Law, Psychology, and Economics are offered to have a multidisciplinary approach in learning.
- Provision to earn credits against Open Electives through MOOC Courses.
- Provision to earn credits through bridge courses for Non-Computer / IT Graduates.

This curriculum aims at the development of an all-rounded personality. It follows a holistic approach of education, ensures mathematics foundation and program core, develops expertise in domain verticals through sequel of electives and HSSE courses.

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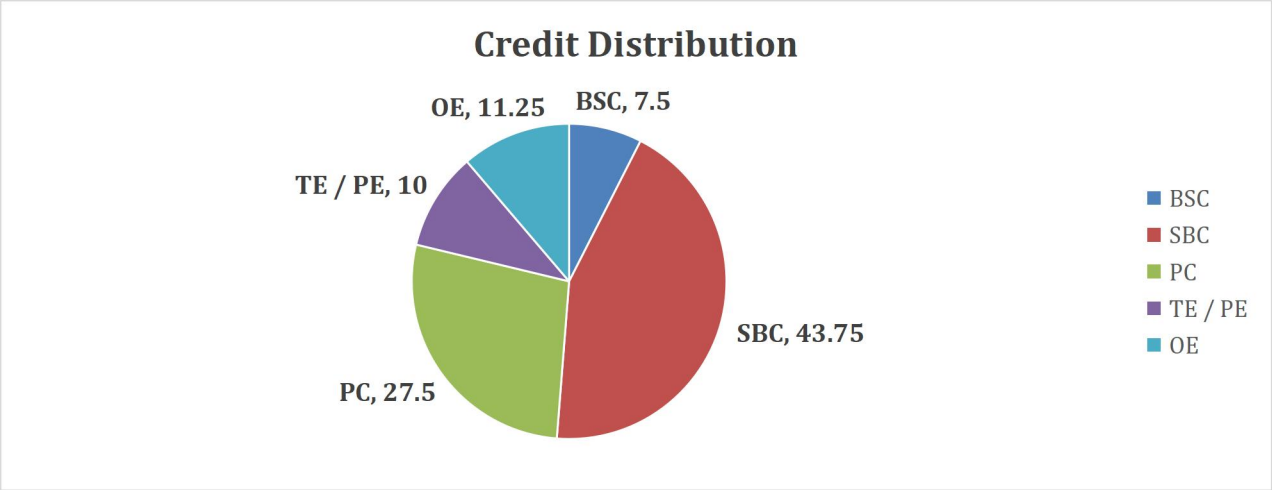
Nomenclature of the Courses		
Groups	**Abbreviation**	**Course Category**
Basic Science Courses	BSC	Basic Science Course
Skill based Courses	SBC	Skilled Based Course
Program Related Courses (PRC)	PC	Program Core
	TE	Thread Elective
	PE	Program Elective
Humanities, Social Science and Management Courses	MLC	Mandatory Learning Course
	OE	Open Elective

Abbreviations			
L	Lecture Hour	SE	Self Engagement in Hours
T	Tutorial Hour	TE	Total Engagement in Hours
P	Laboratory Hour	C	Credit Assigned

S.P.I.T. Credit Structure						
Course Category	**Sem I**	**Sem II**	**Sem III**	**Sem IV**	**Total**	**%**
BSC	3	3	-	-	6	7.5
SBC	5	8	6	16	35	43.75
PC	12	6	4	-	22	27.5
TE / PE	-	4	4	-	8	10
OE	-	-	6	3	9	11.25
Total	**20**	**21**	**20**	**19**	**80**	**100**



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Sem I (For Computer/IT Graduates)									
No	**Type**	**Code**	**Course**	**L**	**T**	**P**	**SE**	**TE**	**C**
1	BSC	MA501	Linear Algebra	2	1	0	5	8	3
2	PC	MC501	Data Structures	3	0	2	4	9	4
3	PC	MC502	Database Management System	3	0	2	5	10	4
4	PC	MC503	Software Engineering	3	0	2	5	10	4
5	SBC	MC504	Web Technology Lab	0	1	4	4	9	3
6	SBC	AS501	Writing Skills	1	0	2	2	5	2
			TOTAL	**12**	**2**	**12**	**25**	**51**	**20**

Sem I (For Non-Computer/IT Graduates)									
No	**Type**	**Code**	**Course**	**L**	**T**	**P**	**SE**	**TE**	**C**
1	BSC	MA502	Linear Algebra & Discrete Mathematics	4	0	0	5	9	4
2	PC	MC501	Data Structures	3	0	2	4	9	4
3	PC	MC502	Database Management System	3	0	2	5	10	4
4	PC	MC503	Software Engineering	3	0	2	5	10	4
5	SBC	MC504	Web Technology Lab	0	1	4	4	9	3
6	PC*	MC505	Problem Solving using OOPs Lab	0	0	2	2	4	1
7	SBC	AS501	Writing Skills	1	0	2	2	5	2
			TOTAL	**14**	**1**	**14**	**27**	**56**	**22**

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Sem II (For Computer/IT Graduates)									
No	**Type**	**Code**	**Course**	**L**	**T**	**P**	**SE**	**TE**	**C**
1	BSC	MA503	Probability and Statistics	3	0	0	4	7	3
2	PC	MC507	Design and Analysis of Algorithms	3	0	2	3	8	4
3	PE	MC5XX-I	Thread Elective-I /Program Elective-I	3	0	2	4	9	4
4	SBC	MC509	Mobile Programming Lab	0	0	4	4	8	2
5	PC	MC506	Advanced Java Programming Lab	0	0	4	3	7	2
6	SBC	MC508	Process Automation Lab	0	1	2	4	7	2
7	SBC	AS502	Communication & Presentation Skills	1	0	2	2	5	2
8	SBC	MC601	Major Project Stage I	0	0	4	0	4	2
			TOTAL	**10**	**1**	**20**	**24**	**55**	**21**

Sem II (For Non Computer/IT Graduates)									
No	**Type**	**Code**	**Course**	**L**	**T**	**P**	**SE**	**TE**	**C**
1	BSC	MA503	Probability and Statistics	3	0	0	4	7	3
2	PC*	MC510	Operating System	2	0	0	4	6	2
3	PC	MC507	Design and Analysis of Algorithms	3	0	2	3	8	4
4	PE	MC5XX-I	Thread Elective-I /Program Elective-I	3	0	2	4	9	4
5	SBC	MC509	Mobile Programming Lab	0	0	4	4	8	2
6	PC	MC506	Advanced Java Programming Lab	0	0	4	3	7	2
7	SBC	MC508	Process Automation Lab	0	1	2	4	7	2
8	SBC	AS502	Communication & Presentation Skills	1	0	2	2	5	2
9	SBC	MC601	Major Project Stage I	0	0	4	0	4	2
			TOTAL	**12**	**1**	**20**	**28**	**61**	**23**

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SUMMER TERM					
No	**Type**	**Code**	**Course**	**TE**	**C**
1	MLC	AS601	Constitution of India	5	NC
2	MLC	AS602	Interview Preparation Skills	30	NC
			TOTAL	**35**	**-**

Sem III (For Computer/IT Graduates)									
No	**Type**	**Code**	**Course**	**L**	**T**	**P**	**SE**	**TE**	**C**
1	OE*	OEXXX	Open Elective-I	3	0	0	5	8	3
2	OE*	OEXXX	Open Elective-II	3	0	0	5	8	3
3	PE	MC5XX-II	Thread Elective-II /Program Elective-II	3	0	2	4	9	4
4	PC	MC511	User Interaction Design	3	0	2	4	9	4
5	SBC	MC602	Major Project Stage II	0	1	8	8	17	5
6	SBC	AS603	Selling and Negotiation Skills	1	0	0	3	4	1
			TOTAL	**13**	**1**	**12**	**29**	**55**	**20**

Sem III (For Non-Computer/IT Graduates)									
No	**Type**	**Code**	**Course**	**L**	**T**	**P**	**SE**	**TE**	**C**
1	PC*	MC527	Computer Networks	2	0	2	3	7	3
2	OE*	OEXXX	Open Elective-I	3	0	0	5	8	3
3	PE	MC5XX -II	Thread Elective-II /Program Elective-II	3	0	2	4	9	4
4	PC	MC511	User Interaction Design	3	0	2	4	9	4
5	SBC	MC602	Major Project Stage II	0	1	8	8	17	5
6	SBC	AS603	Selling and Negotiation Skills	1	0	0	3	4	1
			TOTAL	**12**	**1**	**14**	**27**	**56**	**20**

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Sem IV (For Computer/IT Graduates)									
No	**Type**	**Code**	**Course**	**L**	**T**	**P**	**SE**	**TE**	**C**
1	OE*	OEXXX	Open Elective-III	3	0	0	5	8	3
2	SBC	MC610	6-Month Industry Internship/Research internship at SPIT or Other Institute / Internship with Startup at TBI	0	0	0	0	45	16
			TOTAL	**3**	**0**	**0**	**5**	**53**	**19**

Sem IV (For Non-Computer/IT Graduates)									
No	**Type**	**Code**	**Course**	**L**	**T**	**P**	**SE**	**TE**	**C**
1	OE*	OEXXX	Open Elective-II	3	0	0	5	8	3
2	SBC	MC610	6-Month Industry Internship/Research internship at SPIT or Other Institute / Internship with Startup at TBI	0	0	0	0	45	12
			TOTAL	**3**	**0**	**0**	**5**	**53**	**15**

*** indicates MOOC Courses**

THREAD ELECTIVES

Sr. No.	Thread	Thread Elective I	Thread Elective II
1	**Data Science**	Machine Learning (MC512)	Deep Learning (MC513)
2	**Design**	Design Thinking(MC514)	Total Experience Design (MC515)
3	**Security**	Network and Information Security(MC516)	Cyber Security and Forensics (MC517)
	Any new thread approved by BoS		

PROGRAM ELECTIVES / MOOC	
MC518	DevOps
MC519	Explainable Artificial Intelligence
MC520	Cloud Computing
MC521	Soft Computing
MC522	Block Chain Technology
MC523	Data Warehousing and Mining
MC524	Ethical Hacking
MC525	Software Testing and Quality Assurance
	Any other Course approved by the Dean Academics and Principal

OPEN ELECTIVES / MOOC	
OEHXX	Management Principles
OEHXX	IPR and Patents
OEHXX	Law for Engineers
OEHXX	Economics
OEHXX	Foreign Language
OEHXX	Psychology
OEHXX	Organizational Behavior
OEHXX	Leadership, Innovation and Entrepreneurship
OEHXX	Project Management
OEHXX	Finance for Engineers
OEHXX	Research Methodology
OEHXX	Any course approved by Dean Academics and Principal

Semester	Computer-IT Graduates	Non Computer-IT Graduates
I	20	22
II	21	23
III	20	20
IV	19	15
Total Credits	**80**	**80**

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SEMESTER – I

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	SE	TE	L	T	P	Total
BSC	Linear Algebra	2	1	0	5	8	2	1	0	3
MA501		Examination Scheme								
		Component	ISE	MSE	ESE	Total				
		Theory	20	20	60	100				
		Laboratory	--	--	--	--				

Pre-requisite Course Codes, if any.	Basics of Mathematics
Course Objective: To develop the ability to apply concepts of matrices, vector spaces for solving mathematical and engineering problems.	
Course Outcomes (CO): ***At the End of the course students will be able to***	
MA501.1	Identify types of matrices, find row echelon form, reduced row echelon form, and rank of a matrix.
MA501.2	Apply direct and iterative numerical techniques to obtain solutions of systems of linear algebraic equations and interpret their computational efficiency.
MA501.3	Identify whether given structures are vector spaces and subspaces and construct a basis for them.
MA501.4	Solve equations in real life problems and to encode and decode messages using the concept of matrices.
MA501.5	Examine the eigenstructure of a matrix to determine its diagonalizability and construct its diagonal representation whenever possible.

CO-PO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
MA501.1	3	-	-	-	-	-	-	-	-	-
MA501.2	2	1	-	-	-	-	-	-	1	-
MA501.3	2	1	-	-	-	-	-	-	1	-
MA501.4	3	-	-	-	-	-	-	-	-	-
MA501.5	3	-	-	-	-	-	-	-	-	-

BLOOM'S Levels Targeted

Remember	Understand	Apply ✓	Analyze	Evaluate	Create

Theory Component:

Module No.	Topics	Ref.	Hrs.
1.	**Basics of Matrices & System of Linear Algebraic Equations** Revision of basics of matrices and types of matrices, Row echelon form, Reduced Row Echelon form, Rank of a matrix.	1,2,3,4	03
2.	**System of Linear Algebraic Equations & its Solution** Consistency and solution of simultaneous linear homogeneous and non-homogeneous equations. Solution of system of linear algebraic equations, by (1) Gauss Elimination Method (2) Gauss Jordan method (3) Gauss Jacobi Iteration method (4) Gauss Seidel Method.	1,2,3,4	04
3.	**Vector Spaces (over field of real numbers)** Vector space, subspace with examples, linear span, linear dependence and linear independence of vectors, basis of vector space, dimension of vector space, Null space, Row space, Column space, Rank-Nullity theorem (only statement with examples). Orthogonal Projection & Gram-Schmidt Process of orthogonalization.	1,2,3,4	08
4.	**Application of Matrices** Study of Modular Arithmetic & Implementation of the Hill Cipher method to encode & decode the messages using matrices. Application of matrices in traffic control.	1,2,3,4	05
5.	**Eigenvalues and Eigenvectors** Eigenvalues, Eigenvectors and its properties, Cayley Hamilton Theorem and its applications, Diagonalisation of matrices, Singular Value Decomposition, Functions of a square matrix using diagonalization, Solving system of differential equations using diagonalisation.	1,2,3,4	08
6.	**Self Study** Forming equations using KVL for circuits and solving them using matrices. Least square method. PAQ form. Additional properties with proofs of eigenvalues and eigenvectors.		5*
		Total	**28**

Tutorial Components:

Sr. No.	Title of the Tutorial
1	Row Echelon Form (REF), Reduced Row Echelon Form (RREF) and Rank of a Matrix
2	Solution of Linear Systems using Gauss Elimination and Gauss–Jordan Methods
3	Solution of Linear Systems using Gauss–Jacobi and Gauss–Seidel Iterative Methods
4	Vector Spaces, Subspaces, Linear Dependence/Independence, Basis and Dimension
5	Null Space, Row Space, Column Space and Applications of the Rank–Nullity Theorem
6	Orthogonal Projection and Gram–Schmidt Orthogonalization Process
7	Applications of Matrices: Hill Cipher and Traffic Control Problems
8	Eigenvalues, Eigenvectors and Applications of the Cayley–Hamilton Theorem
9	Diagonalization, Singular Value Decomposition (SVD) and Functions of Square Matrices
10	Solving Systems of Differential Equations using Diagonalization

Text books :

[1] Gilbert Strang ," *Linear Algebra and its applications*", Cengage publications,4th Edition,2014
[2] Dr.B.S.Grewal," *Higher Engineering Mathematics*", Khanna Publications,44th Edition,2020

Reference Books:

[1] David.C.Lay," *Linear Algebra and its applications*", Pearson Education ,3rd Edition,2006
[2] H Anton and Crorres," *Elementary Linear Algebra Application Version*", John and Wiley Sons, 6th Edition,2010
[3] H.K Das ," *Advanced Engineering Mathematics*", S.Chand,28th Edition,2014
[4] Erwin Kreysizg," *Advanced Engineering Mathematics*", 10th Edition, 2011

Online Resources:

(1) Linear Algebra with SageMath A Gentle Introduction
(2) https://math.libretexts.org/Bookshelves/Applied_Mathematics/Applied_Finite_Mathematics_(Sekhon_and_Bloom
(3) https://ocw.mit.edu/courses/18-06sc-linear-algebra-fall-2011/?utm_source
(4) https://nptel.ac.in/courses/111108157?utm_source
(5) https://www.khanacademy.org/math/linear-algebra?utm_source

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	SE	TE	L	T	P	Total
PC	Data Structures	3	0	2	4	9	3	0	1	4
		Examination Scheme								
		Component	ISE		MSE		ESE			Total
MC501		Theory	75		75		150			300
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	Programming
Course Objective: To learn fundamentals of Data Structures.	
Course Outcomes (CO):*At the End of the course students will be able to*	
MC501.1	Apply various operations of Stack, Queue and Linked List to solve problems from different domains.
MC501.2	Apply various operations of Tree and Graph to solve problems from different domains.
MC501.3	Make use of searching and hashing techniques for efficient data retrieval and data mapping.
MC501.4	Make use of various sorting algorithms for efficient data storage.

CO-PO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
MC501.1	3	3	-	2	2	-	-	-	2	-
MC501.2	3	3	-	2	2	-	-	-	2	-
MC501.3	-	-	-	2	2	-	-	-	2	-
MC501.4	-	3	-	2	2	-	-	-	2	-

BLOOM'S Levels Targeted

Remember	**Understand**	**Apply ✓**	**Analyze**	**Evaluate**	**Create**

Theory Component

Module No.	Topics	Ref.	Hrs.
1	**Introduction to Data Structure and Algorithms** Types of Data Structure, Characteristics of an Algorithm, Abstract Data type (ADT)	1,2	2
2	**Linked List, Stack and Queue** **Linked List** (Linked List as an ADT, Linked List Vs. Arrays, Types of Linked List: Singly, Doubly, Circular , Operations of Linked List (Insert, delete, traverse, count, search), Application of Linked List: Polynomial addition and Subtraction) **Stack** (The Stack as an ADT, Stack operations, Array and Linked list Representation of Stack, Application of stack – Evaluation of Postfix expression, Infix to Postfix expression conversion) **Queue** (The Queue as an ADT, Queue operations, Array and Linked Representation of Queue, Circular Queue, Priority Queue. Doubly Ended Queue, Application of Queues – Round Robin CPU Scheduling Algorithm)	1,2	13
3	**Tree and Graph** **Tree** (Tree Definition and Terminologies, Binary Tree, Binary Search Tree, Expression tree, Huffman tree, AVL tree, B Tree, Heap tree) **Graph** (Graph Definition and Terminologies, Graph Representation, Graph Traversal Techniques)	1,2	10
4	**Searching and Hashing Techniques** **Searching** : Sequential search, Binary search, Interpolation Search **Hashing Techniques** (Direct, Subtraction, Modulo Division, Mid square, Digit Extraction, Folding, Double hashing), Collision resolution techniques (Linear probe, Quadratic probe, Key offset, Chaining)	1.2	9
5	**Sorting Techniques** Internal Sorting Techniques (Bubble sort, Insertion sort, Selection Sort, Radix Sort, Quick sort, Heap Sort), External Sorting Techniques (Merge Sort)	1.2	8
6	**Self-Study Topics** Applications of Linked list : Sparse Matrix and other real life applications, Applications of Stack : Recursion and other real life applications, Applications of Queue : Johnson's Algorithm and other real life applications, Applications of Tree, Applications of Graph, Competitive coding		
		Total	**42**

Laboratory Component

Sr. No	Title of the Experiment
1	Linked List implementation
2	Stack implementation
3	Queue implementation
4	Binary Search Tree implementation
5	Heap Tree implementation
6	AVL Tree implementation
7	Graph Traversal (BFS,DFS) implementation
8	Searching Techniques implementation
9	Hashing Techniques implementation
10	Sorting Techniques implementation

Text Books:

[1] T. H. Cormen, C. E. Leiserson, R. L. Rivest, and C Stein, "*Introduction to Algorithms*", MITPress/McGraw Hill, Third Edition, 2009.
[2] Richard F Gilberg, Behrouz A Forouzan, "*Data Structure A Pseudocode Approach with C*", Brooks/Cole Publishing Company, Second Edition, 2004.

Reference Books:

[3] Moshe, Tenenbaum, "*Data Structures Using C and C++*", Pearson Education Asia Pvt. Ltd.,Second Edition, 2006.
[4] Tremblay, Jean-Paul & Sorenson, "*An Introduction to Data Structures with Applications*",Tata McGraw-Hills, Second Edition, 2017.

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Course (Category)	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	SE	TE	L	T	P	Total
PC MC502	Database Management System	3	0	2	5	10	3	0	1	4
		Examination Scheme								
		Component	ISE		MSE		ESE			Total
		Theory	75		75		150			300
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	
Course Objective: To learn the fundamentals of database systems.	
Course Outcomes (CO):*At the End of the course students will be able to*	
MC502.1	Design ER diagram and relational database.
MC502.2	Apply normalization on given database.
MC502.3	Analyze transaction and concurrency control mechanism.
MC502.4	Illustrate emerging database systems.
MC502.5	Formulate SQL queries for information retrieval.
MC502.6	Demonstrate various PL/SQL queries.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
MC502.1	-	2	1	-	1	-	-	-	-	-
MC502.2	3	2	-	-	1	-	-	-	-	-
MC502.3	3	2	-	-	1	-	-	-	-	-
MC502.4	3	2	-	-	1	-	-	-	-	-
MC502.5	3	2	-	2	1	-	-	-	1	-
MC502.6	3	2	-	2	1	-	-	-	1	-

BLOOM'S Levels Targeted

Remember	**Understand**	**Apply**	**Analyze✓**	**Evaluate**	**Create**

Theory Component

Module No.	Topics	Ref.	Hrs.
1	**Introduction to DBMS, ER and Relational Model**	1,2	6
	File system organization, Purpose of Database system, Data models, Codd rules, DBMS architecture, Entity set & Relationship set, Mapping cardinalities, Designing of ER diagram, EER features, ER to Relational Model Designing		
2	**Relation Algebra and Structured Query Language(SQL)**	2,4,5	10
	Introduction to Relation Algebra - Operators in Relational Algebra Structured Query Language - Database Languages, SQL Select, Aggregate Functions, Window Functions, SQL Joins, SQL Subquery		
3	**Normalization, Query optimization and Data Storage Management**	1,2,3	10
	Functional dependency and its types, Normal forms : 1NF, 2NF, 3NF, BCNF Query processing steps, Evaluation of Query, Relational optimization Data Storage structures, Indexing and Hashing		
4	**Transaction and Recovery Management Techniques**	1,2,3	8
	ACID properties, Transaction states, Serializability and its types, Recoverability, Concurrency control mechanism, Lock based protocol, Timestamp based protocol, Recovery Techniques based on Deferred and Immediate Update, Shadow paging and ARIES recovery algorithm		
5	**Distributed Database, Parallel Database**	1,2	8
	Distributed Databases - Overview, Types of Distributed databases, Data fragmentation, replication and allocation techniques, Query processing and Concurrency control Parallel Databases - Architecture, Types of parallelism, Types of Partitioning		
6	**Self-Study Topics**	1,2	
	Tuple Relational Calculus and Domain Relational Calculus, Database Security, Mobile Database, Multimedia Database, Data Storage Structures and Indexing, MongoDB, Cloud DB		
Total			**42**

Laboratory Component

Sr. No.	Title of the Experiment
1	SQL DDL,DML, DCL and TCL statements
2	Design ER diagram and convert it into Relational database
3	SQL Select queries
4	SQL Joins
5	SQL Subqueries
6	PL/SQL Triggers
7	PL/SQL Exceptions
8	PL/SQL Functions, Procedures
9	Data Fragmentation
10	Data Partitioning
11	Mini Project

Text Books:

[1] Henry F. Korth and S. Sudarshan, "*Database System Concepts*", McGraw Hill Education, Seventh Edition, 2019.
[2] Elmasri and Navathe, "*Fundamentals of Database Systems*", Pearson Education, Seventh Edition, 2015.

Reference Books:

[3] C. J. Date, A. Kannan and S. Swamynathan, "*An Introduction to Database Systems*", Pearson education, Eighth Edition, 2003.
[4] Dr. P.S. Deshpande, "*SQL & PL/SQL for Oracle 11g*", Dreamtech Press, First Edition, 2011.
[5] Kevin Loney, "*Oracle Database 11g the complete Reference*", McGraw Hill Education, First Edition, 2009.

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	SE	TE	L	T	P	Total
PC	Software Engineering	3	0	2	5	10	3	0	1	4
		Examination Scheme								
		Component	ISE		MSE		ESE			Total
MC503		Theory	75		75		150			300
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	
Course Objective: To introduce the fundamentals of Software engineering principles and practices.	
Course Outcomes (CO): ***At the End of the course students will be able to***	
MC503.1	Identify software process models for any given problem.
MC503.2	Make use of different requirements and estimation techniques for software Planning.
MC503.3	Construct appropriate models for designing the software.
MC503.4	Apply umbrella activities to Software development.

CO-PO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
MC503.1	-	3	-	-	-	-	-	-	-	1
MC503.2	3	3	-	-	-	3	-	-	-	1
MC503.3	2	-	-	-	-	-	-	-	-	1
MC503.4	2	-	-	-	-	3	-	-	-	1

BLOOM'S Levels Targeted

Remember	**Understand**	**Apply ✓**	**Analyze**	**Evaluate**	**Create**

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Theory Component

Module No.	Topics	Ref.	Hrs.
1	**Introduction to Software Process Models** Software Engineering concepts and Process Models:Prescriptive Model , Evolutionary Process Model:Prototype and Spiral Model , Incremental Model : Iterative approach, RAD model	1,5	6
2	**Agile Process Models** Agile Manifesto:Principles and Values of Agile,Extreme programming, Scrum Life cycle,Feature Driven Development (FDD),Agile Requirements:User stories,Epics CRC,Product Backlog Management	4	7
3	**Requirement Management and Project Scheduling** Functional and Nonfunctional Requirement Elicitation :Interviews ,Questionnaire, Brainstorming, Facilitated Application Specification Technique , Requirement Analysis,Feasibility Study, Types of Feasibility,Software Requirement Specification, Validation Work Breakdown Structure, Gantt Chart, Pert Chart, Critical Path, Agile Estimation Techniques - Planning Poker-Shirt Sizes. Dot Voting, Bucket System.	1,2,3	9
4	**Software Design** Architectural Design: Client Server, Pipe and Filter. Overview of UML Diagrams : Behavioral and Implementation view ,Design Patterns – Gang of four patterns.	5,6	7
5	**Software Testing** Verification & Validation, Overview of White Box Testing and Black Box Testing, Overview of Testing strategies and Agile Testing	1,5	5
6	**Software Umbrella Activities** Risk Management Risk Identification, Risk Assessment, Risk Projection, RMMM ,Software Configuration Management, SCM process, version and change control, Overview of SQA ,McCall's Quality Model	2,4	8
7	**Self-Study Topics** Cohesion and Coupling,Cleanroom Software engineering, 3R - Refactoring Reengineering Reusability		
		Total	**42**

Laboratory Component

Sr. No	Title of the Experiment
1	Prepare Agile requirement using Scrum LifecycleUser Stories ,Epic
2	Prepare an SRS document.
3	Design Use Case diagram and prepare the specification
4	Design Activity and Sequence diagram with specification
5	Design the Implementation and environmental view diagram
6	Create Work Breakdown Structure and Plan for development using Gantt chart
7	Use of Agile Estimation Techniques
8	Prepare test cases and perform Unit Testing (test scenario, test cases, test data)
9	Using Mccall's Quality Factors for Project
10	Study of continuous Integration and development tools.

Text Books:

[1] Roger Pressman,"Software Engineering: A Practitioner Approach",McGraw-Hill, 10thEdition, 2018.
[2] Ian Somerville, "Software Engineering", Addison Wesley, 10 thEdition, 2016.
[3] Mike Cohn, "Agile Estimating and Planning", Prentice Hall, 6thEdition,2018.
[4] Robert C. Martin, "Agile Software Development, Principles, Patterns and Practices", Pearson, 8th Edition, 2013.

Reference Books:

[5] Rajib Mall, "Fundamentals of Software Engineering",PHI,5 th edition,2018.
[6] James Rambaugh, Michael Blaha, "Object Oriented Modeling and Design with UML",Prentice, 2nd edition, 2012.

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	SE	TE	L	T	P	Total
SBC	Web Technology Lab	0	1	4	4	9	0	1	2	3
		Examination Scheme								
		Component	ISE		MSE		ESE			Total
MC504		Theory	-		--		--			--
		Laboratory	200		--		100			300

Pre-requisite Course Codes, if any.	
Course Objective: To learn the fundamentals of HTML,CSS, JavaScript and React.	
Course Outcomes (CO): ***At the End of the course students will be able to***	
MC504.1	Create web pages using HTML5, CSS3, and Java scripting.
MC504.2	Design basic applications using react concepts and components.
MC504.3	Build an application using States, Props and Forms.
MC504.4	Create Navigation structure using nested routes
MC504.5	Understand the basic principles and concepts of Redux and how it works with React.

CO-PO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
MC504.1	3	-	-	2	-	-	-	-	-	-
MC504.2	2	2		3	-	-	-	-	-	-
MC504.3	2	2	2	3	-	-	-	-	-	-
MC504.4	2	2	2	3	-	-	-	-	-	-
MC504.5	2	2	2	3	-	-	-	-	-	-

BLOOM'S Levels Targeted

Remember	Understand	Apply	Analyze	Evaluate	Create✓

Tutorial Component

Sr No	Title of Tutorial
1	To study UI components of HTML File
2	To study different types of CSS and JavaScript
3	To study different types of SASS and JavaScript
4	To combine HTML,CSS and Javascript for a given project
5	To study basics of React and its dependencies
6	To study lifecycle of react and JSX
7	To study Components in React
8	To study Props in React
9	To study Hooks in React
10	To study Routing in react
11	To study Routing in react
12	To study API Calls in react
13	To understand state management in react
14	To understand state management in react

Laboratory Component

Sr. No.	Experiment Details	Ref.
1	Write a basic program using HTML and CSS.	1
2	Create a sample form program that collects the first name, last name, email, user id, and password and confirms password from the user. All the inputs are mandatory and email address entered should be in correct format. Also, the values entered in the password and confirm password textboxes should be the same. After validating using JavaScript, In output display proper error messages in red color just next to the textbox where there is an error.	1
3	Build a dynamic website using HTML,CSS and Javascript	1,7
4	Create and run the application using basic concepts of react	2,3,5,6
5	Create an application using Props and States.	2,3,5,6
6	Create an application using React Form by applying form component, submit and reset theform and validate the form,	5,6
7	Create a single page application. Apply Routing, Dynamically render the components basedonthe URL.	5,6
8	Create an application that demonstrates Hooks	5,6
9	Miniproject based on all the concepts	5,6
10		

Text books:

[1] Thomas A. Powell,"HTML & CSS: The Complete Reference", Fifth Edition,2010
[2] Kirupa Chinnathambi, "Learning React: A Hands-On Guide to Building Web Applications Using React and Redux", O'Reilly, Second Edition, 2018
[3] Anthony Accomazzo, "Fullstack React: The Complete Guide to ReactJS and Friends", Fullstack.io, First Edition, 2017
[4] Mark Tielens Thomas, "React in Action", Manning Publications, First Edition. 2018

Web Reference:

[5] 30 Days of React, Fullstack.io
[6] https://react.dev/learn
[7] https://www.javascript.com/

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	SE	TE	L	T	P	Total
SBC	Writing Skills	1	0	2	2	5	1	0	1	2
		Examination Scheme								
		Component	ISE		MSE		ESE			Total
AS501		Theory	100		--		--			100
		Laboratory	100		--		--			100

Prerequisite Course Codes, if any.	
Course Objective: To strengthen students' vocabulary and grammar skills and to enhance their clear and effective written communication, to acquaint them with effective business-writing principles; develop proficiency in drafting professional and career documents for professional contexts and opportunities.	
Course Outcomes (CO): *At the end of the course, students will be able to*	
AS501.1	Apply principles of scientific vocabulary and grammar in technical communication
AS501.2	Evaluate principles of effective business writing in professional communication
AS501.3	Analyse effective business documents for professional communication
AS501.4	Create effective career documents for professional opportunities

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
AS501.1	-	-	-	-	3	-	-	-	-	-
AS501.2	-	-	-	-	3	-	2	-	-	-
AS501.3	-	-	-	-	3	-	2	-	-	-
AS501.4	-	-	-	-	3	-	-	2	-	-

BLOOM'S Levels Targeted

Remember	Understand ✓	Apply ✓	Analyze ✓	Evaluate ✓	Create ✓

Theory Components

Module No.	Topics	L Hrs	P Hrs.	Ref. Books
1	**English Foundation Skills** Principles of Scientific Vocabulary, Essential Grammar Skills for Technical Writing, Structure, Coherence and Academic Tone in Writing,	3	6	1, 2
2	**Principles of Business Writing** YOU Attitude, Emphasise the positive, Courtesy & Consideration, Clarity & Conciseness, Avoid Jargon	2	4	1, 2, 3
3	**Business Writing Skills** Business E-mail: E-mail Etiquette Types of Email: Inquiry, Complaints and redressal, Meeting: Notice, Agenda, Minutes Report Writing: Analytical report, Proposal Writing	7	14	3, 4
4	**Career Skills - I** Cover Letter and Resume	2	6	3, 4
5	**Basic Language Skills (Self-Study)** Basic Rules of Grammar and Sentence Structures GRE Vocabulary Common errors in writing, confused pairs of words.	2		1, 2

List of ISEs:

Sr. No	Title of the Assignments	Marks
1	ISE 1 – Comprehension Grammar and Vocabulary	15
2	ISE 2 – Principles of Business Correspondence	10
3	ISE 3 – E-mail Writing	20
4	ISE 4 – Proposal Writing	10
5	ISE 5 – Notice & Agenda	10
6	ISE 6 - Minutes of the meeting	15
7	ISE 7 – Report Writing	20
	Total	100

Reference Books:

1. Leech, G. (2005). *English grammar for today*. Palgrave Macmillan.

2. Eastwood, J. (1999). *Oxford practice grammar*. Oxford University Press.

3.Raman, M., & Sharma, S. (2017). *Technical communication: Principles and practice*. Oxford University Press.

4. Mathews, S. (2013). *Communication skills*. Technical Publications.

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	SE	TE	L	T	P	Total
BSC	Linear Algebra & Discrete Mathematics	4	0	0	5	9	4	0	0	4
		Examination Scheme								
		Component	ISE		MSE		ESE			Total
MA502		Theory	100		100		200			400
		Laboratory	–		--		–			–

Pre-requisite Course Codes, if any.	Basics of Mathematics
Course Objective: To provide mathematical foundations of linear algebra and discrete structures for analyzing and solving computational and engineering applications.	
Course Outcomes (CO): ***At the End of the course students will be able to***	
MA502.1	Apply matrix operations, rank methods, and row reduction techniques to solve systems of linear equations.
MA502.2	Analyze vector spaces, subspaces, basis, dimension, and apply orthogonalization techniques.
MA502.3	Determine eigenvalues and eigenvectors and apply matrix transformations, diagonalization, and matrix applications.
MA502.4	Apply concepts of sets, relations, functions, logic, and counting principles to solve discrete mathematical problems.
MA502.5	Analyze graphs, graph representations, graph properties, and algorithms for solving graph-based problems.

CO-PO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
MA502.1	3	-	-	-	-	-	-	-	-	-
MA502.2	3	-	-	-	-	-	-	-	-	-
MA502.3	2	1	-	-	-	-	-	-	1	-
MA502.4	3	-	-	-	-	-	-	-	-	-
MA502.5	2	1	-	-	-	-	-	-	1	-

BLOOM'S Levels Targeted

Remember	Understand	Apply ✓	Analyze	Evaluate	Create

Theory Component

Module No.	Topics	Ref.	Hrs.
1.	**Basics of Matrices & System of Linear Algebraic Equations** Revision of basics of matrices and types of matrices, Row echelon form, Reduced Row Echelon form, Rank of a matrix.	**1,2,3,4**	**03**
2.	**System of Linear Algebraic Equations & its Solution** Consistency and solution of simultaneous linear homogeneous and non-homogeneous equations. Solution of system of linear algebraic equations, by (1) Gauss Elimination Method (2) Gauss Jordan method (3) Gauss Jacobi Iteration method (4) Gauss Seidel Method.	**1,2,3,4**	**04**
3.	**Vector Spaces (over field of real numbers)** Vector space, subspace with examples, linear span, linear dependence and linear independence of vectors, basis of vector space, dimension of vector space, Null space, Row space, Column space, Rank-Nullity theorem (only statement with examples). Orthogonal Projection & Gram-Schmidt Process of orthogonalization.	**1,2,3,4**	**08**
4.	**Application of Matrices**	**1,2,3,4**	**05**

	Study of Modular Arithmetic & Implementation of the Hill Cipher method to encode & decode the messages using matrices. Application of matrices in traffic control.		
5.	**Eigenvalues and Eigenvectors**	**1,2,3,4**	**08**
	Eigenvalues, Eigenvectors and its properties, Cayley Hamilton Theorem and its applications, Diagonalisation of matrices, Singular Value Decomposition, Functions of a square matrix using diagonalization, Solving system of differential equations using diagonalisation.		
6.	**Set Theory and Logic**	**5, 6, 7**	**12**
	Finite and infinite set, Union, Intersection, Disjoint, and Difference of two sets. Power Set, Ordered Sets, De Morgan's Laws, Inclusion Exclusion Principle. Predicates, Propositions, Conditional Propositions, Logical Connectivity, Proposition calculus, Universal and Existential Quantifiers, Well-ordering principle.		
7.	**Relations and Functions**	**5, 6, 7**	**10**
	Product Sets and Partitions, Properties of Relations, Equivalence Relations, Operations on Relations, Composition of Functions, Pigeon hole Principle.		
8.	**Graph Theory**	**5, 6, 7**	**06**
	Concepts and terminologies, Graphs as Model (Konigsberg Bridge Problem), Matrices, Isomorphism, Bipartite Graphs, Directed Graphs.		
9.	**Self-Study Topics**		**05***

	Least square method. Additional properties with proofs of eigenvalues and eigenvectors. Algebraic Structures - Semi group, Monoids, Groups, Cyclic groups, Abelian groups, Normal Subgroups		
		Total	**56**

Text Books:

[1] Gilbert Strang ," *Linear Algebra and its applications*", Cengage publications,4th Edition,2014
[2] Dr.B.S.Grewal," *Higher Engineering Mathematics*", Khanna Publications,44th Edition,2020
[3] Kenneth H. Rosen , "*Discrete Mathematics and it's applications",* Tata McGraw- Hill, Seventh edition, 2013.
[4] Bernad Kolman, Robert Busby, Sharon Cutler Ross, Nadeem-ur-Rehman, "*Discrete Mathematical Structures",* Pearson Education, Sixth edition, 2015.

Reference Books:

[1] David.C.Lay," *Linear Algebra and its applications*", Pearson Education ,3rd Edition,2006
[2] H Anton and Crorres," *Elementary Linear Algebra Application Version*", John and Wiley Sons, 6th Edition,2010
[3] H.K Das ," *Advanced Engineering Mathematics*", S.Chand,28th Edition,2014
[4] Erwin Kreysizg," *Advanced Engineering Mathematics*", 10th Edition, 2011
[5] C. L. Liu, "*Elements of Discrete Mathematics",* Tata McGraw- Hill, Fourth edition, 2012.
[6] Douglas B. West, "*Introduction to graph Theory",* Pearson Education, Second edition, 2015.
[7] Jean-Paul, Tremblay R. Manohar, "*Discrete Mathematical Structures with Applications to Computer Science",* Tata McGraw- Hill, First edition, 1987.

Online References:

(1) Linear Algebra with SageMath A Gentle Introduction
(2) https://math.libretexts.org/Bookshelves/Applied_Mathematics/Applied_Finite_Mathematics_(Sekhon_and_Bloom)
(3) **https://nptel.ac.in/courses/106106183?utm_source**
(4) **https://ocw.mit.edu/courses/6-042j-mathematics-for-computer-science-spring-2015/?utm_source**

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	SE	TE	L	T	P	Total
PC	Problem solving using OOP Lab	0	0	2	2	4	0	-	1	1
		Examination Scheme								
		Component	ISE		MSE		ESE		Total	
MC505		Theory	--		--		--		--	
		Laboratory	50		--		50		100	

Pre-requisite Course Codes, if any.	
Course Objective: To learn fundamentals of Problem solving using OOP using Core JAVA.	
Course Outcomes (CO): *At the End of the course students will be able to*	
MC505.1	Understand various Java programming basic constructs
MC505.2	Apply OOP concepts such as inheritance Polymorphism with Exception handling in the real world problem
MC505.3	Examine applicability of multithreading concept for scenario based learning
MC505.4	Analyze real time problem with database connection and file handling using JAVA concepts

CO-PO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
MC505.1	3	3	-	-	-	-	-	-	-	-
MC505.2	3	3	-	-	-	-	-	-	-	1
MC505.3	-	-	-	3	-	-	-	-	-	-
MC505.4	-	3	-	-	-	-	-	-	-	1

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze ✓	Evaluate	Create

Laboratory Component

Sr. No	Title of the Experiment
1	JAVA program focusing on data types and operators
2	JAVA program focusing on Methods
3	JAVA program focusing on Constructors
4	JAVA program focusing on Inheritance
5	JAVA program focusing on packages, arrays
6	JAVA program focusing on Multithreading
7	JAVA program focusing on File handling
8	Design and implementation of Exception handling
9	JAVA program focusing on database connection
10	Implementation of Generics and Collections

Text Books

[1] Herbert schildt, "The complete reference JAVA" Tata McGraw Hill, Seventh 2007
[2] Sharanam Shah and Vaishali Shah "Core Java for beginner" SPD 2010

Reference Books

[1] K. Arnold and J. Gosling "The JAVA programming language" Pearson Education thirdedition2008
[2] Black Book "Java server programming J2EE" Dream Tech Publishers first edition 2008
[3] James Keogh "Complete Reference J2EE" McGraw Hill Education Indian Edition 2001
[4] Claudio Eduardo de Oliveira, Dinesh Rajput, Rajesh R V "Spring MVC: Beginner's Guide"Packt Second edition 2016
[5] Paul Tepper, Fisher, Brian Murphy "Spring Persistence with Hibernate" Springer-Verlag Berlinand Heidelberg GmbH & Co. KG First edition 2001

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	SE	TE	L	T	P	Total
SBC	Writing Skills	1	0	2	2	5	1	0	1	2
		Examination Scheme								
		Component	ISE		MSE		ESE			Total
AS501		Theory	100		--		--			100
		Laboratory	100		--		--			100

Prerequisite Course Codes, if any	

Course Objective: To strengthen students' vocabulary and grammar skills and to enhance their clear and effective written communication, to acquaint them with effective business-writing principles; develop proficiency in drafting professional and career documents for professional contexts and opportunities.

Course Outcomes (CO): *At the end of the course, students will be able to*

AS501.1	Apply principles of scientific vocabulary and grammar in technical communication
AS501.2	Evaluate principles of effective business writing in professional communication
AS501.3	Analyse effective business documents for professional communication
AS501.4	Create effective career documents for professional opportunities

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
AS501.1	-	-	-	-	3	-	-	-	-	-
AS501.2	-	-	-	-	3	-	2	-	-	-
AS501.3	-	-	-	-	3	-	2	-	-	-
AS501.4	-	-	-	-	3	-	-	2	-	-

BLOOM'S Levels Targeted

Remember	Understand ✓	Apply ✓	Analyze ✓	Evaluate ✓	Create ✓

Theory Components

Module No.	Topics	L Hrs	P Hrs.	Ref. Books
1	**English Foundation Skills** Principles of Scientific Vocabulary, Essential Grammar Skills for Technical Writing, Structure, Coherence and Academic Tone in Writing,	3	6	1, 2
2	**Principles of Business Writing** YOU Attitude, Emphasise the positive, Courtesy & Consideration, Clarity & Conciseness, Avoid Jargon	2	4	1, 2, 3
3	**Business Writing Skills** Business E-mail: E-mail Etiquette Types of Email: Inquiry, Complaints and redressal, Meeting: Notice, Agenda, Minutes Report Writing: Analytical report, Proposal Writing	7	**14**	**3, 4**
4	**Career Skills - I** Cover Letter and Resume	2	6	3, 4
5	**Basic Language Skills (Self-Study)** Basic Rules of Grammar and Sentence Structures GRE Vocabulary Common errors in writing, confused pairs of words.	2		1, 2

List of ISEs:

Sr. No	Title of the Assignments	Marks
1	ISE 1 – Comprehension Grammar and Vocabulary	15
2	ISE 2 – Principles of Business Correspondence	10
3	ISE 3 – E-mail Writing	20
4	ISE 4 – Proposal Writing	10
5	ISE 5 – Notice & Agenda	10
6	ISE 6 - Minutes of the meeting	15
7	ISE 7 – Report Writing	20
	Total	100

Reference Books:

1.Leech, G. (2005). *English grammar for today*. Palgrave Macmillan.

2.Eastwood, J. (1999). *Oxford practice grammar*. Oxford University Press.

3.Raman, M., & Sharma, S. (2017). *Technical communication: Principles and practice*. Oxford University Press.

4.Mathews, S. (2013). *Communication skills*. Technical Publications.

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SEMESTER – II

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[Department of Computer Science and Engineering (Master of Computer Applications)]

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	SE	TE	L	T	P	Total
BSC	Probability And Statistics	3	0	0	4	7	3	0	0	3
		Examination Scheme								
		Component	ISE		MSE		ESE			Total
MA503		Theory	75		75		150			300
		Laboratory	--		--		--			--

Pre-requisite Course Codes, if any.	Basics of Mathematics & Statistics
Course Objective: To develop statistical and probabilistic skills for analyzing data, modeling uncertainty, and making data-driven decisions in engineering applications.	
Course Outcomes (CO): ***At the End of the course students will be able to***	
MA503.1	Compute measures of central tendency, dispersion, and represent data using various statistical diagrams.
MA503.2	Apply probability concepts, conditional probability, and Bayes' theorem to solve uncertainty-based problems.
MA503.3	Analyze random variables and probability distributions to determine statistical parameters and their applications.
MA503.4	Apply correlation, regression, sampling techniques, and estimation methods for data analysis.
MA503.5	Perform hypothesis testing using Z-test, t-test, and Chi-square test for statistical decision making.

CO-PO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
MA503.1	3	-	-	-	-	-	-	-	-	-
MA503.2	3	-	-	-	-	-	-	-	-	-
MA503.3	2	1	-	-	-	-	-	-	2	-
MA503.4	1	2	-	-	-	-	-	-	2	-
MA503.5	1	2	-	-	-	-	-	-	2	-

BLOOM'S Levels Targeted

Remember	Understand	Apply ✓	Analyze	Evaluate	Create

Theory Component:

Module No.	Topics	Ref.	Hrs.
1.	**Measure of Central Tendencies**	**1,2**	**6**
	Continuous Frequency Distribution, Histogram, Frequency Polygon, Stem and Leaf Diagram, Ogives, Arithmetic Mean, Geometric Mean, Harmonic Mean, Median, Range, Quartile Deviation, Mean Deviation, Box Whisker Plot, Variance, Standard Deviation, Coefficient of Variation.		
1.	**Introduction to the Probability**	**1,2**	**4**
	Random Experiment, Sample space, Events, definition of probability, addition rule and multiplication rule of probability, Conditional Probability, Bayes' Theorem and Independence.		
3.	**Random Variables & Probability Distributions**	**1,2**	**10**
	Random Variables - Discrete & Continuous Random variables, Expectation, Variance, Covariance and Correlation, Moments, Moment Generating Functions Standard discrete distributions - Binomial, Poisson, Standard continuous distributions – Normal Probability Mass Function (PMF), Probability Density Function (PDF) and Cumulative distribution function (CDF).		
4.	**Correlation & Regression**	**1,2**	**4**
	Correlation, Karl Pearson's coefficient of correlation (by Actual Mean method), Spearman's rank correlation coefficient, Linear Regression and Estimation (for one independent variable), Coefficients of regression.		
5.	**Sampling Distribution**	**1,2**	**8**
	Population and Sample, Simple Random Sampling, Sampling Distribution, Sampling Distribution of Sample Mean, Sampling Distribution of Proportion, Standard Error, Central Limit Theorem (only theorem with applications), Large Sample Tests, Large Sample Test for Difference Between Two Sample Means		

6.	**Testing of Hypothesis**	**1,2**	**10**
	Statistical hypothesis - Null and Alternate hypothesis, One-tailed and two-tailed tests, Level of Significance, Confidence Interval, Test Statistics, Critical region and Acceptance region. Type I and Type II errors, Level of Significance, Large Sample Tests - Z-test for single sample mean, Difference between two population means Small Sample Tests - Student's t-distribution, One-sample t-test, Two-sample t-test (independent samples) Chi-Square test: Test of Goodness of Fit		
7.	**Self Study**		**4***
	Outlier Detection using Box Plot Uniform distribution, Geometric distribution Standard discrete distributions: Bernoulli's Linear regression for two independent variables		
		Total	**42**

Text Books:

[1] J.Susan Milton, Jesse C. Arnold," Introduction to Probability & Statistics", Tata McGraw Hill, 4th Edition, 2014
[2] Kishore Trivedi, "Probability And Statistics with Reliability, Queuing, And Computer Science Applications", Wiley Publication, 2nd Edition, 2018

Reference Books:

[1] Dr. J. Ravichandran, "Probability&StatisticsforEngineers", Wiley, 1st Edition, 2010
[2] Schaum's, "Outlines Probability, Random Variables & Random Process", Tata McGraw Hill ,3rd Edition, 2017.

Online Resources:

1.NPTEL: https://nptel.ac.in/courses/111105090

2.https://stats.libretexts.org/Courses/Las_Positas_College/Math_40%3A_Statistics_and_Probability

3.https://www.khanacademy.org/math/statistics-probability?utm_source

4.https://stats.libretexts.org/Bookshelves/Introductory_Statistics?utm_source

Bharatiya Vidya Bhavan's
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[Knowledge is Nectar]
[Department of Computer Science and Engineering (Master of Computer Applications)]

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	SE	TE	L	T	P	Total
PC	Design and Analysis of Algorithms	3	0	2	3	8	3	0	1	4
		Examination Scheme								
		Component	ISE		MSE		ESE			Total
MC507		Theory	75		75		150			300
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	Data Structures
Course Objective: To develop the ability to analyze and evaluate the time and space complexity of various algorithms. To decompose a problem into simpler sub problems and solve them effectively. To provide an optimum solution for a range of computational problems.	
Course Outcomes (CO):*At the End of the course students will be able to*	
MC507.1	Analyze time and space complexity of different algorithms.
MC507.2	Analyze various divide & conquer algorithms.
MC507.3	Apply greedy and dynamic method to given problem.
MC507.4	Make use of backtracking, branch and bound techniques, graphs to solve a problem.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO 2
MC507.1	3	3	1	1	-	-	-	1	-	-
MC507.2	2	3	2	1	-	-	-	1	-	-
MC507.3	2	2	2	1	-	-	-	1	-	-
MC507.4	2	2	2	1	-	-	-	1	-	-

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	**Understand**	**Apply**	**Analyze**	**Evaluate ✓**	**Create**

Theory Component

Module No.	Topics	Ref.	Hrs.
1	**Fundamentals of Algorithmic problem solving and efficiency**	1,2	6
	The Role of Algorithms in Computing, Growth of Functions, The substitution method, master method, Recursion tree method. Time complexity: worst case, best case, average case analysis, space complexity. Asymptotic notations (Big O, Omega, Theta).		
2	**Analysis of various algorithms and Divide and Conquer**	1	6
	Binary Search analysis, Merge sort analysis, Quick sort analysis Matrix multiplication, Internal Sorting Techniques, External Sorting, Techniques, Complexity calculation of Sorting Techniques using Asymptotic notation		
3	**Greedy Method & Dynamic Programming**	3,2	8
	Introduction to Greedy method, Fractional Knapsack problem, Minimum cost spanning tree- kruskal and prims algorithm **Introduction to Dynamic programming** 0/1 Knapsack problem, Matrix Chain Multiplication, Longest Common Subsequence.		
4	**Backtracking**	1	7
	Introduction to Backtracking method, 8 queens problem, Graph coloring. Hamiltonian cycles, Travelling Salesman Problem.		
5	**Branch and Bound**	1	7
	Introduction to Branch and bound technique, FIFO and LIFO branch and bound, 15 puzzle problem, Travelling salesman problem		
6	**Graph algorithm**	1,2	8
	Single source shortest path- Dijkstra's algorithm, Bellman Ford Algorithm, All pair shortest path-Floyd Warshalls algorithm, Max Flow Algorithm: Ford-Fulkerson method, Maximum Bipartite Matching.		

7	**Self-Study Topics**		
	String Matching Algorithm : Brute Force String matching , Naïve String matching algorithm, Rabin Carp string matching		
	Total	**42**	

Laboratory Component

Sr. No.	Title of the Experiment
1	To implement Divide and conquer method (Merge and Quick Sort)
2	To implement Divide and conquer method (Matrix Multiplication and Strassen's Matrix Multiplications)
3	To implement Greedy Technique (Fractional Knapsack Problem)
4	To implement Dynamic algorithms (0/1 Knapsack)
5	To implement Dynamic algorithms (Matrix Chain Multiplication)
6	To implement Backtracking algorithm (N-Queens Problem)
7	To implement branch and bound algorithm (Travelling Salesman Problem)
8	To implement Single source shortest path (Dijkstra's Algorithm)
9	To implement All pair shortest path (Floyd Warshal Algorithm)
10	To implement String matching algorithm (Rabin Karp Algorithm)

References:

[1] T. H. Cormen, C. E. Leiserson, R. L. Rivest, and C Stein, "*Introduction to Algorithms*", MIT Press/McGraw Hill,2012 Version, 2/E, PHI Learning, 3rd Edition,
[2] S. Baase, S and A. Van Gelder, "*Computer Algorithms: Introduction to Design and Analysis*",Addison Wesley, 2000, 3rd edition.
[3] Michael Gooddrich& Roberto Tammassia, "*Algorithm design foundation, analysis and internet examples*", Second edition , wiley student edition.

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[Department of Computer Science and Engineering (Master of Computer Applications)]

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	SE	TE	L	T	P	Total
SBC	Mobile Programming Lab	0	0	4	4	8	0	0	2	2
		Examination Scheme								
		Component	ISE		MSE		ESE			Total
MC509		Theory	--		--		--			--
		Laboratory	100		--		100			200

Pre-requisite Course Codes, if any.	Web Technology
Course Objective: To equip students with the necessary skills and knowledge to build cross-platform mobile applications using Flutter. The course will cover the complete development lifecycle, from environment setup to advanced features like Firebase integration, real life projects etc.	
Course Outcomes (CO): ***At the End of the course students will be able to***	
MC509.1	Installation of Flutter environment with all dependencies.
MC509.2	Design applications using flutter concepts and components.
MC509.3	Create application using Database
MC509.4	Create real life application on a given scenario.

CO-PO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
MC509.1	1	-	2	3	-	-	-	1	1	1
MC509.2	3	-	2	3	-	-	-	1	1	1
MC509.3	3	-	2	3	-	-	-	1	1	1
MC509.4	3	1	2	3	1	-	-	1	1	1

BLOOM'S Levels Targeted

Remember	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create✓**

Laboratory Component

Sr. No.	Experiment Details	Ref.
1	Install and configure Flutter development environment and create basic application.	1,5,7
2	Creating first app of User Profile with flutter with UI elements.	1,2,3, 5,7
3	Building an app for Navigation and Routing	1,3,4,5, 7
4	Create forms and handle user input in a Flutter app.	1,2,3,5, 7
5	Create an app for MCA Department	1,2,4,5, 7
6	Create an app for Children studying in Jr KG and Sr KG	1,3,4,5, 7
7	Create an app for a restaurant to deliver food at doorstep.	1,5,7
8	Implement user authentication using Firebase.	1,5,7
9&10	Miniproject based on all the concepts.	1,5,7

Text books:

[1] "Flutter for Beginners: An Introductory Guide to Building Cross-Platform Mobile Applications with Flutter and Dart 2" by Alessandro Biessek, Packt Publishing, 2019.
[2]"Beginning Flutter: A Hands-On Guide to App Development" by Marco L. Napoli, Wiley,2019
[3]"Flutter Projects: A practical, project-based guide to building real-world cross-platform mobile applications and games" by Simone Alessandria, Packt Publishing, 2020
[4] "Flutter Cookbook: Over 100 Proven Techniques and Solutions for Mobile Developers" by Simone Alessandria and Brian Kayfitz, Packt Publishing,2021

Web Reference:

[5] https://flutter.dev/

[6] https://firebase.flutter.dev/docs/overview/

[7] https://docs.flutter.dev/get-started/install

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	SE	TE	L	T	P	Total
PC	Advanced Java Programming	0	0	4	3	9	-	-	2	200
		Examination Scheme								
		Component	ISE		MSE		ESE			Total
MC506		Theory	--		--		--			--
		Laboratory	100		--		100			200

Pre-requisite Course Codes, if any.	OOP, Core JAVA
Course Objective: To provide students with practical exposure to design and development of Java-based desktop and web applications using AWT, Servlets, JSP, JDBC, and the Java Collection Framework and to enable students to develop enterprise applications using Spring Framework and Spring Boot by applying modern web technologies, RESTful services, and microservices architecture.	
Course Outcomes (CO): *At the End of the course students will be able to*	
MC506.1	Design and develop dynamic web applications using JavaServer Pages (JSP) with session and cookie management techniques.
MC506.2	Develop enterprise web applications using Servlets, JDBC, and database connectivity for request processing and business logic implementation.
MC506.3	Apply Java Collection Framework and GUI programming concepts to develop efficient and interactive Java applications.
MC506.4	Design and develop enterprise applications using Spring Framework and Spring Boot, including RESTful web services and microservices-based architectures.

CO-PO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
MC506.1	3	3	-	-	-	-	-	-	-	-
MC506.2	3	3	-	-	-	-	-	-	1	-
MC506.3	-	-	-	3	-	-	-	-	-	-
MC506.4	-	3	-	-	-	-	-	-	1	1

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create✓

Laboratory Component

Sr. No.	Title of the Experiment
1	Design and develop graphical user interface (GUI) applications using Java AWT components, event handling, and layout managers.
2	Develop dynamic web applications using Java Servlets to process client requests, manage responses, and implement business logic for real-world scenarios.
3	Design dynamic web pages using JavaServer Pages (JSP) with standard directives, scripting elements, and reusable components for web application development.
4	Implement session management techniques in JSP-based web applications to maintain user-specific information across multiple requests.
5	Develop web applications demonstrating client-side state management using Cookies and related mechanisms in JSP applications.
6	Develop database-driven web applications integrating Servlets, JSP, and JDBC to perform data storage, retrieval, validation, and reporting operations.
7	Develop enterprise applications using the Spring Framework and Spring Boot, demonstrating dependency injection, configuration, and application architecture concepts.
8	Design and develop RESTful web services using Spring Boot, implementing CRUD operations, request handling, validation, and response management.
9	Design and implement a Microservices-based application using Spring Boot, demonstrating service decomposition, inter-service communication, and API integration.
10	Mini Project: Design and develop a full-stack enterprise web application using Spring Boot demonstrating user management, authentication, CRUD operations, database integration, and deployment-ready architecture.

Note: Course Supervisor may consider a single case study for implementing above programs.

References:

Textbook

Sr. No.	Title	Edition	Authors	Publisher	Year
1	Advanced Java Programming	3rd Edition	Uttam K. Roy	Oxford University Press	2015
2	Core Java Volume II – Advanced Features	12th Edition	Cay S. Horstmann	Pearson	2022
3	Spring in Action	6th Edition	Craig Walls	Manning Publications	2022

Reference Books

Sr. No.	Title	Edition	Authors	Publisher	Year
1	Head First Servlets and JSP	2nd Edition	Bryan Basham, Kathy Sierra, Bert Bates	O'Reilly Media	2008
2	Spring Boot in Action	1st Edition	Craig Walls	Manning Publications	2016
3	Java: The Complete Reference	13th Edition	Herbert Schildt	McGraw-Hill	2024
4	Beginning Spring Boot 3	3rd Edition	Greg L. Turnquist	Apress	2023

Online Resources

- Oracle Java Documentation – https://docs.oracle.com/javase/
- Jakarta EE Documentation – https://jakarta.ee/
- Spring Framework Documentation – https://spring.io/projects/spring-framework
- Spring Boot Documentation – https://spring.io/projects/spring-boot
- Spring Guides – https://spring.io/guides
- Apache Tomcat Documentation – https://tomcat.apache.org/
- Maven Documentation – https://maven.apache.org/
- Baeldung Java Tutorials – https://www.baeldung.com/
- GeeksforGeeks Java Portal – https://www.geeksforgeeks.org/java/
- Oracle JDBC Documentation – https://docs.oracle.com/javase/tutorial/jdbc/

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[Department of Computer Science and Engineering (Master of Computer Applications)]

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	SE	TE	L	T	P	Total
SBC	Process Automation	0	1	2	4	7	0	1	1	2
		Examination Scheme								
		Component	ISE		MSE		ESE			Total
MC508		Theory	-		-		-			-
		Laboratory	100		-		100			200

Pre-requisite Course Codes, if any.	s
Course Objective: To give students exposure about process automation, its working, importance and security related to it.	
Course Outcomes (CO):*At the End of the course students will be able to*	
MC508.1	Identify the use of RPA platform in performing a task.
MC508.2	Make use of sequence and control flow as per the requirements.
MC508.3	Make use of data manipulation concepts to solve real time problems.
MC508.4	Evaluate dynamic user interface explorer to handle events.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
MC508.1	2	2	2	3	1	-	-	-	2	-
MC508.2	2	2	2	3	1	-	-	-	2	-
MC508.3	2	2	2	3	1	-	-	-	2	-
MC508.4	2	2	2	3	1	-	-	-	2	-

BLOOM'S Levels Targeted

Remember	Understand	Apply	Analyze	Evaluate	Create✓

Laboratory Component

Sr. No	Title of the Experiment
1	Downloading and installation of RPA tools and running a simple bot.
2	Understanding of actions available in the RPA tools.
3	Design a calculator using IF activity
4	Recording an action of logging into LinkedIN account and create a post.
5	Data Scrapping from a website and store it in the database.
6	Excel automation
7	PDF automation
8	Email automation
9	Error and Exception handling
10	Deploying and maintaining the bot.

Text Books:

[1]. Alok Mani Tripathi, Learning Robotic Process Automation, Packt Publishing,2018
[2] Frank Casale, Rebecca Dilla, Heidi Jaynes , Lauren Livingston, Introduction to Robotic Process Automation:
[3].a Primer, Institute of Robotic Process Automation.2015.

Reference Books:

[4] Richard Murdoch, Robotic Process Automation: Guide to Building Software Robots, Automate Repetitive Tasks & Become an RPA Consultant, Independently Published,2018.
[5] Srikanth Merianda, Robotic Process Automation Tools, Process Automation and their benefits: Understanding RPA and Intelligent Automation, CreateSpace Independent Publishing Platform, 2018

Web References:

[1] https://www.uipath.com/rpa/robotic-process-automation
[2] https://www.automationanywhere.com/

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Course (Category) Code	Course Name	Teaching Scheme (Hrs./week)					Credits Assigned			
		L	T	P	SE	TE	L	T	P	Total
SBC	Communication and Presentation Skills	1	0	2	2	5	1	0	1	2
AS502		Examination Scheme								
		Component	ISE		MSE		ESE			Total
		Theory	-		--		--			-
		Laboratory	100		--		--			100

Prerequisite Course Codes, if any.	
Course Objective: The course aims to enhance students' communication, presentation, research, and academic writing skills while developing critical thinking, problem-solving, and professional competencies essential for academic and career success	
Course Outcomes (CO): *At the End of the course students will be able to*	
AS502.1	Demonstrate effective presentation, persuasion, and interpersonal communication skills in professional settings
AS502.2	Apply research, technical writing, citation, and research ethics principles
AS502.3	Analyse academic texts using critical reading techniques to identify key ideas and research gaps
AS502.4	Apply creative thinking, decision-making, and problem-solving skills effectively

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
AS502.1	-	-	-	-	3	-	2	2	-	-
AS502.2	-	-	-	-	-	-	3	2	-	-
AS502.3	-	-	-	-	-	-	3	2	-	-
AS502.4	-	-	-	-	2	-	2	2	-	-

BLOOM'S Levels Targeted (Pl. appropriate)

Remember	Understand ✓	Apply ✓	Analyze ✓	Evaluate ✓	Create ✓

Theory Components

Module No.	Topics	Ref. Books	L Hrs.	P Hrs.
1	**Presentation Skills** How to begin confidently, engage the audience, explain ideas, body language and how to deliver an impactful presentation	1, 2	2	4
2	**Career Skills – II** Group Discussion Skills, Persuasion using facial expressions, gestures, body language; persuasion using voice, verbal style, verbal content, Interview skills, Corporate Etiquette	1, 2	5	10
3	**Research Skills** What is research? Types of research, Citation styles – a glimpse, Basic Literature Review, Academic Writing for Research	3, 4	3	4
4	**Advance Reading Skills for Researchers** Critical reading of journal papers and reports, identifying research gaps **Critical Reading Techniques:** • SQ3R (Newspaper articles) • PQ4R (Journal Articles)	1, 2, 3	2	4
5	**Creative Thinking and Problem-Solving** Decision-making and problem-solving skills Workplace Etiquettes	4	2	4
6	**Self-Study** Code of Conduct for Research		2	-

List of ISEs

Sr. No.	Title of the Experiment	Marks
1	Mock Interview	20
2	Group Discussion	20
3	Presentation	20
4	Research – APA Style	10
5	Creative Thinking and Problem-Solving	15
6	Workplace Etiquettes	15
	Total	100

Reference Books

1. Bovée, C. L., Thill, J. V., & Chatterjee, A. *Business communication: Process & product* (3rd ed., Indian adaptation). McGraw-Hill Education.
2. Sen, L. *Communication Skills* (2nd ed.). Prentice-Hall of India.
3. Kothari, C. R., & Garg, G. *Research Methodology: Methods and techniques* (4th ed.). New Age International Publishers.
4. Raman, M., & Sharma, S. *Technical communication: Principles and practice*. Oxford University Press.

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	SE	TE	L	T	P	Total
SBC	Major Project -I	0	0	4	0	4	0	0	4	2
MC601		Examination Scheme								
		Component	ISE		MSE		ESE			Total
		Theory	--		--		--			--
		Laboratory	100		--		100			200

Course Objective: This course inculcates self-learning, research and entrepreneurship attitude in students. It aims to sharpen problem solving skills for societal benefits by solving real world problems. Students will be able to understand the formal project development process to complete a project in a team. It will help students to develop communication, organizational skills and maturity through discussion, presentation etc.

Course Outcomes (CO): ***At the End of the course students will be able to***

MC601.1	Identify and analyze project objectives, scope, and constraints through literature surveys, stakeholder discussions, and technical feasibility studies.
MC601.2	Formulate clear and structured Problem Statements by breaking down complex challenges into manageable tasks and sub-tasks.
MC601.3	Develop Preliminary Design Concepts
MC601.4	Perform Data Collection and Analysis
MC601.5	Document and communicate the project's background, approach, and expected outcomes through written proposals, oral presentations, or progress reviews.

CO-PO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
MC601.1	2	2	1	1	3	3	3	3	1	1
MC601.2	2	3	2	2	3	3	3	3	1	2
MC601.3	2	3	3	2	2	2	3	3	1	3
MC601.4	2	3	-	3	2	1	3	3	1	3
MC601.5	2	1	1	-	3	3	3	3	2	2

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BLOOM'S Levels Targeted

Remember	Understand	Apply	Analyze	Evaluate	Create✓

Major Project- I is an opportunity to inculcate the research aptitude in students. It helps them to identify research gaps and come up with possible solutions. Students should be able to analyze these solutions for feasibility of their implementation.Major Project- I is based on a small research project correlating scientific knowledge and day to day experience which encourages research inclination among the students to solve societal problems.

Steps for Research:

(5) Keen observation of the surrounding/society

(6) Read existing Literature to understand and identify the research gaps

(7) Analysis of the problem

(8) Formulation of the problem statement

(9) Collection of relevant information by formulating research questions

(10) Suggesting plan of action

(11) Conducting experiments and draw conclusion

(12) To find the possible solution to rectify the problem

(13) To execute experiments and remedial measures wherever possible

(14) To publish results

Students can seek guidance from teachers, other experts and make effective use of other sources of information available

around them. Students must ensure that the problem is manageable in one semester.

Criteria of a good project:

- Appropriate idea, clear understanding, and proper presentation of the concept
- Quality of work
- Project plan and its execution
- Credibility of the work
- Probable impact of the work on the attitude of students and society
- Scientific attitude, creativity and novelty reflected in project work and analysis of thesituation
- Utility and innovation of the remedial measures

- Desirability, Feasibility and Viability in real life

The H/W and S/W resources required to complete the Major Project- I may be beyond the scope of curriculum of courses taken or may be based on the courses but thrust should be on

✔ Learning additional skills
✔ Development of ability to define and design the problem and lead to its accomplishment with proper planning
✔ Learn behavioral discipline. Students should function effectively as an individual

Evaluation:

Major Project- I report shall be submitted in a PDF copy. Other sections of the report shall be decided by the mentor based on projects. But it must have introduction, necessity of project, objectives, hypothesis, plan, observations, and analysis of results, conclusion, and references along with other sections related to technology.

The ISE(Phase I and Phase II) and ESE evaluation will be carried out based on the rubrics framed by the Department. ISE marks will be based on the performance of the individual student in the evaluation.The ESE marks will be based on demonstration in front of the expert appointed by the Department. In the ESE examination each individual student would be assessed for her contribution in selecting the originality of the problem statement, understanding and knowledge gained about the task completed through presentation/demonstration, work done, and preparing the technical report/presentations/poster/technical paper of the project in the standard format provided by the Department.

Following Parameters are evaluated during ISE(Phase I and Phase II) and ESE by project guide and external expert.
P1: Problem Identification & Literature Survey (Problem Definition/Idea/Originality/Scope & objectives/Feasibility/Application in Society/ Gap identification/Relevance of references/Adequate references)
P2: Analysis & Design (UML diagrams: Use case, Class, and Sequence diagram/Block diagram/Algorithms)
P3: Implementation (work done up to 25 %)
P4: Presentation (Coverage of topic/use of graphics/Delivery & Speaking skills) and Ethics (Attitude/Deadline/Distribution of Work)
P5: Social Relevance

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	SE	TE	L	T	P	Total
PC	Operating System	2	0	0	4	6	2	0	0	2
		Examination Scheme								
		Component	ISE		MSE		ESE			Total
MC510		Theory	50		50		100			200
		Laboratory	--		--		--			--

Pre-requisite Course Codes, if any.	
Course Objective: To learn fundamentals of Operating System.	
Course Outcomes (CO): ***At the End of the course students will be able to***	
MC510.1	Illustrate the fundamentals of operating system services
MC510.2	Apply process scheduling Algorithm and concurrency control techniques
MC510.3	Make use of memory management algorithms in effective allocation of main memory usage.
MC510.4	Apply the basic concepts of File systems and problems related to security and protection

CO-PO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
MC510.1	3	2	-	-	-	-	-	-	-	-
MC510.2	3	2	-	2	-	-	-	-	-	-
MC510.3	3	2	-	2	-	-	-	-	-	-
MC510.4	-	3	-	-	-	-	-	-	-	-

BLOOM'S Levels Targeted

Remember	**Understand**	**Apply ✓**	**Analyze**	**Evaluate**	**Create**

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(Empowered Autonomous Institute Affiliated to University of Mumbai)
[Knowledge is Nectar]
[Department of Computer Science and Engineering (Master of Computer Applications)]

Theory Component

Module No.	Topics	Ref.	Hrs.
1	**Introduction to Operating System** Introduction to OS and System software, concept of process and threads Types of OS-Batch, multiprocessing, multitasking, timesharing, system calls ,types of System calls	1,2	5
2	**CPU scheduling** CPU scheduling algorithms-FCFS, SJF, RR, Priority, Pre- emptive, Non-preemptive, Multiprocessor scheduling algorithms, Real time scheduling algorithm	1,2	9
3	**Concurrency Control** Concurrency and Race Conditions, Mutual exclusion requirements, Semaphores, Monitors, Classical IPC problems and solutions, Deadlock, Characterization, Detection, Recovery, Avoidance and Prevention	1,2	10
4	**Memory Management** Memory partitioning, Swapping, Paging, Demand paging, Virtual memory concepts, Page replacement algorithms, Disk scheduling, Disk management, Swap-space management, Allocation algorithms	1,2	9
5	**File Systems and Protection & Security** File systems- File concept, Access methods, Allocation methods, Directory systems, File protection, Free space management, Protection & Security Goals of protection, Domain of protection, Access matrix, Implementation of access matrix	1,2	9
6	**Self-Study Topics** Study of different Operating, Systems(Linux, Windows, Android OS, iOS) Shell Scripting		
Total			**42**

Text Books:

1. Silberschatz and Galvin, *"Operating System Concepts*",Wiley Publications,9th Edition,2012.
2. Andrew S. Tanenbaum, *" Modern Operating Systems*" , Pearson Education Publishers,4th Edition,2016.

Reference Books:

3. William Stallings, "*Operating Systems –Internals and Design Principles*", 8/E, Pearson Publications,2014.
4. Godbole and Kahate,"*Operating Systems*",McGraw Hill,3rd edition 2017.

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	SE	TE	L	T	P	Total
MLC	Interview Preparation Skills (Summer term)	-	-	-	-	30	-	-	-	NC
		Examination Scheme								
		Component	ISE		MSE		ESE		Total	
AS602		Theory	-		-		-		-	
		Laboratory	-		-		-		-	
Prerequisite Course Codes, if any.										
Course Objective: This course prepares students for campus placements and professional life through structured mock interviews and, group discussions, spoken English, and workplace etiquettes.										
Course Outcomes (CO): *At the End of the course, students will be able to*										
AS602.1		Demonstrate effective professional communication skills in English for academic and workplace contexts, including self-introduction, interviews, and group discussions								
AS602.2		Develop and present an ATS-friendly resume and an optimised LinkedIn profile that effectively communicate professional qualifications and career competencies								
AS602.3		Apply appropriate interview skills, including responses to HR and basic technical questions, confident verbal communication, positive body language, and professional etiquette								
AS602.4		Demonstrate an understanding of workplace expectations, professional behaviour, and communication practices relevant to the software industry								

CO-PO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
AS602.1	-	-	-	-	3	-	3	-	-	-
AS602.2	-	-	-	-	3	-	3	-	-	-
AS602.3	-	-	-	-	3	-	3	-	-	-
AS602.4	-	-	-	-	3	-	3	-	-	-

BLOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand ✓	Apply ✓	Analyze ✓	Evaluate	Create ✓

Module No.	Topics	Ref.	Hrs.
1	**Presentation Skills, Building Confidence & Spoken Communication** Confidence building, common mistakes, thinking in English, Greetings, introductions, asking questions, small talk, Voice clarity, pronunciation, fluency, filler words, active listening, Audience confidence, handling nervousness, structuring ideas, storytelling. **Activities**: Icebreakers, one-minute introduction, confidence self-assessment, Read-aloud, explaining a technical concept in simple English, Pair conversations, speaking drills, natural unscripted practice, each student delivers a 4–7-minute presentation.	**1, 3**	10
2	**Professional Oral and Written Communication, Teamwork & Workplace Behaviour, Non-verbal Communication** Professional attitude, positive thinking, self-awareness, emotional intelligence, Collaboration, responsibility, time management, accountability, respect at work, Body language, appearance, discipline, eye contact, smile, gestures, posture, handshake, Email writing, WhatsApp etiquette, meeting etiquette, online interview etiquette, Phone Etiquette, LinkedIn profile optimisation, professional headline & summary writing, connecting with recruiters, online personal branding. Activity: Each student builds/refines a LinkedIn profile and peer-reviews one other student's profile. **Activities:** SWOT analysis and reflection, Team games and a problem-solving challenge, Role plays to interpret and practice communication styles through body language, writing professional emails and running mock virtual meetings	**1, 2, 4**	6
3	**Placement Preparation**	**5, 6**	14

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	GD rules, listening skills, speaking opportunities, current-affairs discussion, Resume structure, ATS-friendly resume, projects, internships, skills, common mistakes, bridging technical depth with soft skills: describing your MCA project/DSA concepts to a non-technical or mixed panel, handling technical follow-up questions calmly, Tell-me-about-yourself, strengths, weaknesses, career goals, why-hire-you, conflict resolution, failure stories, team experiences. Activity: **Activities:** Two live group discussions with structured feedback, Students prepare their own resumes, explain their resume, Mock interviews, individual feedback for improvement, Trainer Review		

Reference Books:

1) Alex, K. *Soft Skills: Know Yourself and Know the World*. 4th ed., S. Chand Publishing, 2025.

2) Talbot, Fiona. *How to Write Effective Business English: The Essential Toolkit for Composing Powerful Letters, E-mails and More for Today's Business Needs*. Kogan Page, 2009.

3) Carnegie, Dale. *The Quick and Easy Way to Effective Speaking*. Rupa Publications India, 2016.

4) Pease, Allan, and Barbara Pease. *The Definitive Book of Body Language*. Orion Publishing, 2004.

5) Verma, Shalini. *The Ultimate Guide to Job Interview Preparation*. McGraw Hill Education, 2018.

6) Raman, Meenakshi, and Sangeeta Sharma. *Technical Communication: Principles and Practice*. 3rd ed., Oxford University Press, 2015.

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SEMESTER – III

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	SE	TE	L	T	P	Total
		3	0	2	4	9	3	0	1	4
PC	User Interaction Design	Examination Scheme								
		Component	ISE		MSE		ESE			Total
MC511		Theory	75		75		150			300
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	
Course Objective: This course provides an opportunity to learn and apply the design principles of Human Machine Interaction. Learners will learn the basic human psychology of everyday actions and will be able to design an UI prototype of an application. This course covers the discussion on various interaction design concepts. The laboratory experiments are designed to practice the concepts and to adopt the systematic approach for interface design using various UX tools.	
Course Outcomes (CO):*At the End of the course students will be able to*	
MC511.1	Identify the various design principles used for interacting between human and machine.
MC511.2	Apply human psychology of everyday actions and UI design processes for real world applications.
MC511.3	Implement mobile, windows, and web-based application
MC511.4	Evaluate and justify UI design
MC511.5	Create an application for a social and technical task.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
MC511.1	-	2	-	-	-	-	1	-	-	-
MC511.2	-	2	2	2	-	-	-	-	-	-
MC511.3	-	2	2	2	-	-	2	1	1	-
MC511.4	-	2	2	2	-	-	2	2	1	-
MC511.5	-	2	3	2	-	-	-	2	1	-

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply ✓	Analyze	Evaluate	Create

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Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	**Introduction**	T1-T4	08
	1.1	Introduction to Human Machine Interface, Hardware, software and operating environment to use HMI in various fields, The psychopathology of everyday things – complexity of modern devices; human-centered design; fundamental principles of interaction, Psychology of everyday actions- how people do things; the seven stages of action and three levels of processing; human error.		
2	Title	**Graphical User Interface and Web Interface**	T2,T4	06
	2.1	The Graphical User Interface: Popularity of graphics, the concept of direct manipulation, characteristics of GUI, Web user Interface: Interface popularity, characteristics. Principles of user interface design.		
3	Title	**Understanding Goal-Directed Design**	T1-T4	08
	3.1	Goal-directed design; Implementation models and mental models; Beginners, experts, and intermediates – designing for different experience levels, Understanding users; Modeling users – personas and goals.		
4	Title	**Design Guidelines**	T1-T4	08
	4.1	Perception, Gestalt principles, visual structure, reading is unnatural, color, vision, memory, six behavioral patterns, recognition and recall, learning, factors affecting learning, and time.		
5	Title	**Interaction Styles and Communication:**	T2,T4	08
	5.1	**Interaction Styles:** Menus, Windows, Device-based and Screen-based Controls. **Communication:** Text messages, Feedback, and Guidance, Icons, Multimedia, and colors.		
6	Title	**Laws of User Interface**	T3	04
		Fitt's law, Hick's law, Doherty Threshold, Goal Gradient Effect, Law of common region, Miller's Law, Parkinson's Law, Postels' Law, Tesler's Law.		
	Self Study	UX tools: Figma, Just In Mind, and any open-source tool for prototype designing Mobile Ecosystem: Platforms, Application frameworks: Types of Mobile Applications: Widgets, Applications.		

Total	**42**

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	To Study of open-source UX tools (Justinmind Prototype, Pidoco, Marvel ,Figma Prototype) and create a simple design for a given problem definition.
2	**Know your client.** a. Design an app that can teach mathematics to children of 4-5 years age in schools in Rural Sector. b. Design an app that can teach mathematics to children of 4-5 years age in schools in Urban Sector. c. Design a site that can help people to sell their handmade products in metro cities. d. Design a site that can connect housewives and keep them engaged. **Note : Students should be able to do the following for any given problem statement** i. Analysis of user's/client's behavior eg their preferences, interests etc **ii.** What kind of interfaces will they like and why? **iii.** Existing apps - analyze and rate them. **iv.** What will be your choice of screen elements? **v.** How will your app/web design be better than the existing one?
3	**Goal-oriented design** - Design an experience for passengers whose flight /train is delayed.
4	**Design Principles** - Understand principles of good UI design by heuristic evaluation. Design UI for a given problem statement.
5	**Menus & Navigation** – Redesign of a user interface (Suggest and implement changes in Existing User Interface) for a given problem statement.
6	**Windows & Screen controls** – Design UI for a given problem statement. **a.** Design a navigator for a student new in your Institute. **b.** Design a navigator for a person new in tourist city/ village. **c.** Motor paralysis for differently able people. **d.** Vaccination App design with localization
7	**Icons** - Design appropriate icons pertaining to a given domain. (Eg. Greeting cards, Travelling, restaurants, Education, Medical, security at Airport, Malls etc)
8	**Colors** – Design a personal website for any socio-technical problem. Use color guidelines with statistical graphics for better visualization.
9	Design a Map-based UI(Web User) for the given problem statement. Example: Mumbai Dabbawallas with localization feature. Pet Care New Visitors to Hospital

10	To calculate the screen complexity of the existing Graphical User Interface and redesign the interface to minimize the screen complexity.

Text Books

1. Alan Dix, J. E. Finlay, G. D. Abowd, and R. Beale, Human Computer Interaction, 3rd ed., Pearson, Prentice Hall, 2003.
2. Wilbert O. Galitz, The Essential Guide to User Interface Design, 3rd ed., Wiley publication, 2007.
3. Donald A. Norman, Design of Everyday Things, 2nd ed., Basic Books; Reprint edition, 2013.
4. Kalbande, Kanade, and Iyer, Galitz's Human Machine Interaction, 1st ed., Wiley Publications, 2015.

Reference Books

1. Rogers, Sharp, and Preece, Interaction Design: Beyond Human Computer Interaction, 5th ed., Wiley publications, 2019.
2. Brian Fling, Mobile Design and Development, 1st ed., O'Reilly Media Inc., 2009.

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	SE	TE	L	T	P	Total
SBC	Major Project-II	0	1	8	8	17	0	1	4	5
		Examination Scheme								
		Component	ISE		MSE		ESE			Total
MC602		Theory	--		--		--			--
		Laboratory	300		--		200			500

Pre-requisite Course Codes, if any.	
Course Objective: This course inculcates self-learning, research, and entrepreneurship attitude in students. It aims to sharpen problem solving skills and application development by taking up real world problems. Students will be able to understand the formal project development process to complete a project in a team. It will help students to develop communication, organizational skills and maturity through discussions, presentations etc. Students will be able to write technical research paper.	
Course Outcomes (CO): ***At the End of the course students will be able to***	
MC602.1	Apply Advanced Technical Knowledge to solve real-world problems within the project scope.
MC602.2	Design, develop, and implement effective solutions by integrating multidisciplinary approaches
MC602.3	Test prototypical solution using advanced tools
MC602.4	Develop effective interpersonal and communication skills in project development.
MC602.5	Understand professional, ethical, legal, industry practices and responsibilities.

CO-PO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
MC602.1	3	3	3	2	2	2	2	1	3	3
MC602.2	3	2	3	3	3	1	2	1	3	3
MC602.3	1	1	3	3	1	2	2	1	3	3
MC602.4	1	1	1	1	3	1	2	3	3	3
MC602.5	1	1	1	1	3	3	3	2	3	3

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**BLOOM'S Levels Targeted **

Remember	Understand	Apply	Analyze	Evaluate	Create ✓

Sr. no	Tutorial Name
1	Introduction to Research Methodology. Importance of good Research.
2	Analysis of Research - defining a Problem statement from the analysis
3	Motivation Factor for Research
4 & 5	Types of Research
6	Process of performing Literature Review
7	Formulation of Problem Definition
8	Hypothesis and its types
9 & 10	Formation and presentation of Result Analysis
11 & 12	Research paper structure writing

Major Project - II is an opportunity to inculcate problem solving aptitude in students. It helps them to identify requirements and come up with feasible solutions. Students should be able to analyze these solutions for feasibility of their implementation. Major Project - II is based on an application development project correlating industry practices, tools and methodologies and day to day experience which encourages development of interpersonal skills among students to solve real life problems.

Steps for Project:

✓ Keen observation of the surrounding/society
✓ Read existing Literature to understand and identify the research gaps
✓ Analysis and formulation of the problem
✓ Design/ Develop the solution
✓ Conducting experiments and draw conclusion
✓ Perform testing by creating test cases
✓ Prepare the documentation in each phases
✓ Submit the final project report

Students can seek guidance from teachers, other experts and make effective use of other sources of information available around them. Students must ensure that the problem is manageable in one semester.

Criteria of a good project:

✓ Appropriate idea, clear understanding, and proper presentation of the concept
✓ Quality of work
✓ Project plan and its execution
✓ Credibility of the work
✓ Probable impact of the work on the attitude of students and society
✓ Scientific attitude, creativity and novelty reflected in project work and analysis of the situation
✓ Utility and innovation of the remedial measures
✓ Desirability, Feasibility and Viability in real life

The H/W and S/W resources required to complete the Major Project - II **may be beyond the scope of curriculum of courses taken or may be based on the courses but thrust should be on**

✔ Learning additional skills
✔ Development of ability to define and design the problem and lead to its accomplishment with proper

planning

✔ Learn behavioral discipline by working in a team. Students should work in groups of three on Major Project - II

Evaluation:

Project report shall be submitted in a pdf copy. Other sections of the report shall be decided by the mentor based on projects. But it must have introduction, necessity of project, objectives, hypothesis, plan, observations, and analysis of results, conclusion, and references along with other sections related to technology.

The ISE(Phase I and Phase II) and ESE evaluation will be carried out based on the rubrics framed by the Department. ISE marks will be based on the performance of the individual student in the evaluation.The ESE marks will be based on demonstration in front of the expert appointed by the Department. In the ESE examination each individual student would be assessed for her contribution in selecting the originality of the problem statement, understanding and knowledge gained about the task completed through presentation/demonstration, work done, and preparing the technical report/poster/technical paper of the project in the standard format provided by the Department.

Following Parameters are evaluated during ISE(Phase I and Phase II) and ESE by project guide and external expert.
P1: Technical Competency (Understand project technicality/Design exceeds project objectives)
P2: Work done (100 % Implementation/ Meets project objectives/result analysis/test cases/solution shows originality)
P3: Presentation (Coverage of topic/use of graphics/Delivery & Speaking skills/Presentation length) and Ethics (Attitude/Deadline/Distribution of Work)
P4: Report (in latex)
P5: Research paper (in IEEE format with Plagiarism report)

Research Paper Publication and participation in Research / Project Competition is mandatory for Project II to earn the required credits.

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	SE	TE	L	T	P	Total
PC	Computer Networks	2	0	2	3	7	2	0	1	3
		Examination Scheme								
		Component	ISE		MSE		ESE			Total
MC527		Theory	50		50		100			200
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	
Course Objective: To learn fundamentals of Computer Networks.	
Course Outcomes (CO): ***At the End of the course students will be able to***	
MC527.1	Illustrate the fundamental concepts of Networking.
MC527.2	Identify the different types of Internetworking devices, topologies and their functions
MC527.3	Make use of various Protocols, Services and features of the layered architecture of Networking
MC527.4	Apply knowledge of different Algorithms within the Network.

CO-PO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
MC527.1	2	-	-	-	-	-	-	-	-	-
MC527.2	-	3	-	-	-	-	-	-	-	-
MC527.3	3	3	-	3	-	-	-	-	-	-
MC527.4	3	3	-	3	-	-	-	-	-	-

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply ✓	Analyze	Evaluate	Create

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Theory Component

Module No.	Topics	Ref.	Hrs.
1	**Basics of Computer Network** Topology & types of topologies, types of networks, LAN, MAN, WAN, types of communications (Asynchronous and synchronous)	1,2	3
2	**Networking models** ISO-OSI Reference Model, Internet Model (TCP/IP), Comparison of ISO-OSI & TCP/IP Model, Connectivity Devices, Passive & Active Hubs, Switch, Bridges, Gateways	1,2	5
3	**Overview of Media Layers** Physical Layer components, Data Link Layer –Logical Link control, Framing Methods, Error Detection & Correction techniques, Data Link Layer – Medium Access control protocols, CSMA (CD and CA), Reservation, Polling, Token Passing, IP addressing - Addressing Subnets, IP – IPv4, IPv6, Address mapping -ARP, RARP, BOOTP, Internet Control Management Protocol, Internet Group Management Protocol, VLAN Routing Protocols –RIP, EIGRP and OSPF.	2,4	12
4	**Overview of Host Layers** Transport layer -The TCP protocol and the TCP Segment Header, UDP, Congestion control techniques, Application layer – Simple Network Management, Protocol, Electronic Mail on the Internet	1,2,3	8
5	**Self-Study Topics** Software Defined Networking, ALOHA and its types, NAT. Static NAT, Dynamic NAT		
		Total	**28**

Textbooks:

[1] Kurose & Ross, "*Computer Networking: A Top-Down Approach*", Pearson,6th Edition, 2017.
[2] Behrouz Forouzan, "*Data communication and Networking*", Tata McGrawHill,4th Edition 2012.

Reference Books:

[3] Behrouz Forouzan, "*TCP/IP Protocol Suite*", Tata McGraw Hill,4th Edition,2010
[4] Andrew Tanenbaun, "*Computer Networks*", PHI,5th Edition, 2012.

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SEMESTER – IV

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	SE	TE	L	T	P	Total
SBC	6-Month Industry Internship/Research internship at SPIT or Other Institute / Internship with Startup at TBI	--	--	--	--	45	--	--	--	16
		Examination Scheme								
		Component	Phase 1		Phase 2		ESE			Total
MC610		Laboratory	100		100		100			100

Note: 16 Credits fo Computer/IT Graduates and 12 Credits for Non Computer/IT Graduates

Pre-requisite Course Codes, if any.	
Course Objective:	
Course Outcomes (CO):*At the End of the course students will be able to*	
MC610.1	Apply the software engineering principles to solve real life problems using modern tools, used in the organization
MC610.2	Apply the software project management processes to carry out the successful completion of project
MC610.3	Use professional ethics in application development
MC610.4	Develop skills for working in the team and for life-longlearning

CO-PO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
MC610.1	2	2	2	2	2	2	2	2	2	2
MC610.2	2	2	2	2	2	2	2	2	2	2
MC610.3	2	2	2	2	2	2	2	2	2	2
MC610.4	2	2	2	2	2	2	2	2	2	2

BLOOM'S Levels Targeted (Pl. Tick appropriate)

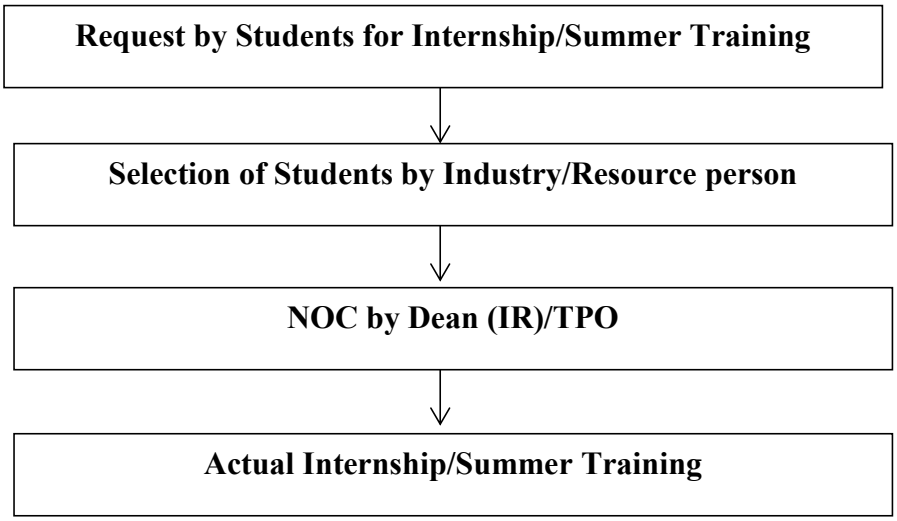
Remember	Understand	Apply	Analyze	Evaluate ✓	Create

MSE (Phase 1): (First 3-Months Evaluation),
MSE (Phase II): (Next 3-Months Evaluation)

Guidelines:

1. Students need to select a company for an internship, or can work under the guidance of an internal mentor. If a student is not selected to work in industry for an internship project, an internal mentor needs to organize a project in the college itself which may be in accordance with Academic rules of the institute. Max. 3 students shall be allotted one internal mentor in case a student does not get an industry internship.
2. Every student should submit a joining letter along with their project proposal within 4 weeks of joining an internship in the company. Project proposal should include company information, External mentor information, project abstract and tool (tentatively) working.
3. Phase 1 and Phase 2 evaluation will be conducted as per the time table defined by the Internship coordinator.
4. Every student shall make a draft of a project report and get it accessed by an internal mentor. The Project report should contain an Introduction to Project, which should clearly explain the project scope in detail.
5. During evaluation faculty must follow the rubrics prepared for respective evaluation given by IR cell.

Figure 1: Process for calling internship through Faculty



Process for calling internship through IR cell/TPO , SPIT.

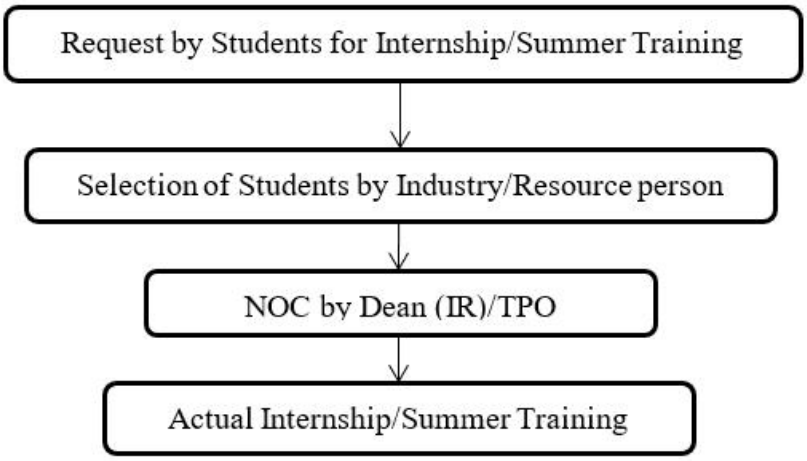


Figure 3.2 : Process for industry internship/summer training

Step1. IR CELL committee members/Faculty Coordinators send a request via mail to industries /Resource Person through TPO for providing the internship to students.

Step2. Once a response is received, a mail is forwarded to all the students regarding the internship offer containing the details about the subject domain, scope and project description and the same will be displayed on Notice Board (Industry Relation).

Step3. The IR CELL student committee collects the details of interested students from each department and prepares the list with areas of interest and skills.

Step4. The list is then forwarded to Industry and it is shortlisted by them.

Step5. The selected students are then called for a test and interview by respective companies.

Step 6. Industry offers appointments to selected students with terms and conditions and a copy of the same is kept with the IR cell and Faculty coordinators will send the copies of the selected students to other departments for departmental record.

An internship will be canceled during Internship period in case of any complaints about the Interns received from the Industry /Research Institute Personnel to Dean (IR). No students can avail the benefits of any kind of internship without prior approval and verification by the Dean (IR). A waiver in attendance will be granted only for the approved period of Internship. The Internship period will not be considered for getting the benefits in attendance marks.

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THREAD / PROGRAM ELECTIVES

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(Empowered Autonomous Institute Affiliated to University of Mumbai)
[Knowledge is Nectar]
[Department of Computer Science and Engineering (Master of Computer Applications)]

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	SE	TE	L	T	P	Total
TE	Machine Learning	3	0	2	4	9	3	0	1	4
		Examination Scheme								
		Component	ISE		MSE		ESE			Total
MC512		Theory	75		75		150			300
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	**Linear Algebra**
Course Objective: To introduce basic concepts and techniques of machine learning and develop skills of using recent machine learning software for solving practical problems.	
Course Outcomes (CO):*At the End of the course students will be able to*	
MC512.1	Explain basic concept and need of machine learning
MC512.2	Apply machine learning algorithms to solve the given problem
MC512.3	Explain various reinforcement learning techniques
MC512.4	Apply Dimensionality reduction techniques.
MC512.5	Make use of basic concepts of Python/R to solve given problems.

CO-PO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO 2
MC512.1	3	-	-	-	-	-	-	-	-	-
MC512.2	3	3	3	3	-	-	-	-	2	-
MC512.3	2	-	-	-	-	-	-	-	-	-
MC512.4	2	2	-	-	-	-	-	-	1	-
MC512.5	2	2	2	-	1	-	-	-	2	-

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create ✓**

Theory Component

Module No.	Topics	Ref.	Hrs.
1	**Introduction To Machine Learning**	1,2,4	8
	Need of machine learning, machine learning vs AI, machine learning vs Deep learning ,Learning types : Supervised Learning, Unsupervised learning, Reinforcement learning, What makes Machine Learning tick purpose or objectives, variety of algorithms- learning style, similarity style, Applications of machine learning, General Steps or Process of Machine Learning- SourceX -> Feature Extraction -> Feature Correlation -> Feature TransformX-> Train Model-> Ensemble-> Evaluate Capacity, Overfitting and Underfitting, Hyperparameters and Validation Sets. Estimators, Bias and Variance, likelihood, Gradient Descent. Data Visualization basics		
2	**Supervised Learning**	1,2,4	14
	Hypothesis testing, Training versus Testing, Over fitting & Regularization ,Regression: Regression fundamentals, Linear Regression, Regularization technique , Classification: Classification fundamentals, Evaluation metrics, Logistic Regression, Decision trees,-CART,-Random Forest, Naïve Bayes , Support Vector Machine, K-Nearest Neighbor ,Case Study(Classification),		
3	**Unsupervised Learning**	1,2,3	6
	Clustering basics: K-means clustering, Association Rule Learning , Hierarchical Clustering,K-medoid clustering		
4	**Dimensionality Reduction**	2	6
	Feature Engineering, Feature Selection methods, - Filters; Wrappers, Embedded, PCA, SVD		
5	**Reinforcement Learning**	2,3,5	4
	Basics,Markov Decision, Monte Carlo Prediction, QLearning,Case Study (next best offer, dynamic pricing)		
6	**Machine Learning Applications across Industries**	1,2,3	4
	Healthcare, Retail, Financial Services, Hospitality		
7	**Self-Study Topics**		
	Cloud Based ML Offerings, Comparing Machine Learning as a Service: Amazon, Microsoft Azure, Google Cloud AI, IBM		
	Watson, Explore tools used in ML, TensorFlow, Keras, Scikit learn		
	Total		**42**

Laboratory Component

Sr. No	Title of the Experiment
1	**Introduction to Python/R** Introduction Python/R, Python/R data types and objects, reading and writing data, Python/R Packages
2	**Data Preprocessing in Python/R** Perform data preprocessing on the given problem statement in Python/R
3	**Data Visualization** Perform Data Visualization on the given problem statement Create Visualization Dashboards
4	Apply Linear regression
5	Apply Logistic regression
6	Apply Decision tree algorithm for the given problems
7	Apply Random Forest algorithm for the given problems
8	Apply Naïve Bayes algorithm for the given problems
9	Apply K means clustering for the given problem
10	Apply PCA for the given problem

Text Books:

[1] Kevin P. Murphy, "Probabilistic Machine Learning An Introduction",Cambridge, Massachusetts : The MIT Press, [2022]

[2] Shai Shalev-Shwartz and Shai Ben-David*," Understanding Machine Learning: From Theory to Algorithms*", Cambridge University Press, 1st Edition,2014

[3] Mehryar Mohri Afshin , Rostamizadeh ,Ameet Talwalkar," *Foundation of Machine Learning*", The MIT Press, 2nd Edition,2018

Reference Books:

[4] Gareth James, Daniela Witten, Trevor Hastie Robert Tibshirani," *An Introduction to Statistical Learning*", Springer, 7th Edition,2007

[5] Andrew Ng, *Machine Learning Yearning*, Deeplearning.ai, Draft v0.5, 2018

[6] Dr Dinesh Kumar," *Machine-learning-using-python*", WileyIndia,1st Edition, 2019

Web References:

[7]https://www.altexsoft.com/blog/datascience/comparing-machine-learning-as-a-service-amazon-microsoft-azure-google-cloud-ai-ibm-watson/\

[8]https://cloud.google.com/products/ai

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	SE	TE	L	T	P	Total
TE	Deep Learning	3	0	2	4	9	3	0	1	4
		Examination Scheme								
		Component	ISE		MSE		ESE			Total
MC513		Theory	75		75		150			300
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	Probability and statistics, Artificial Intelligence, Machine learning
Course Objective: To enable the students to know deep learning techniques to support real-time applications	
Course Outcomes (CO): ***At the End of the course students will be able to***	
MC513.1	Summarize in-depth understanding of Deep Neural Networks
MC513.2	Employ regularization techniques in the design of Deep Neural Networks
MC513.3	Experiment with advanced concepts of Convolution Neural Networks, Autoencoders and Recurrent Neural Networks
MC513.4	Apply deep learning techniques for object identification and segmentation

CO-PO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
MC513.1	2	2	2	-	-	-	-	-	1	-
MC513.2	2	2	2	2	-	-	-	-	1	-
MC513.3	2	2	2	2	-	-	-	-	1	-
MC513.4	2	2	2	2	-	-	-	-	1	-

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	**Understand**	**Apply**	**Analyze ✓**	**Evaluate**	**Create**

Theory Component

Module No.	Topics	Ref.	Hrs.
1	**Training, Optimization of Deep Neural Network**	1,2	08
	Training Feedforward DNN : Multi Layered Feed Forward Neural Network, Learning Factors, Activation functions: Tanh, Logistic, Linear, Softmax, ReLU, Leaky ReLU, Loss functions: Squared Error loss, Cross Entropy, Choosing output function and loss function Optimization : Learning with backpropagation, Learning Parameters: Gradient Descent (GD), Stochastic and Mini Batch GD, Momentum Based GD, Nesterov Accelerated GD, AdaGrad, Adam, RMSProp		
2	Regularization	1,2	06
	Overview of Overfitting, Types of biases, Bias Variance Tradeoff Regularization Methods: L1, L2 regularization, Parameter sharing, Dropout, Weight Decay, Batch normalization, Early stopping, Data Augmentation, Adding noise to input and output		
3	**Autoencoders**	1,2	07
	Unsupervised Learning Introduction, Linear Autoencoder, Undercomplete Autoencoder, Overcomplete Autoencoders, Regularization in Autoencoders Denoising Autoencoders, Sparse Autoencoders, Contractive Autoencoders, Variational Autoencoders (VAE) and Generative Adversarial Networks (GAN), Application of Autoencoders		
4	**Convolutional Networks**	1.2	08
	Convolutional Neural Networks (CNN): Supervised Learning Convolution operation, Padding, Stride, Relation between input, output and filter size, CNN architecture: Convolution layer, Pooling Layer, Weight Sharing in CNN, Fully Connected NN vs CNN, Variants of basic Convolution function Modern Deep Learning Architectures: LeNET: Architecture, AlexNET: Architecture, application of CNN (such as Breast cancer detection using CNN)		
5	**Recurrent Neural Networks (RNN)**	1.2	08

	Sequence Learning Problem, Unfolding Computational graphs, Recurrent Neural Network, Bidirectional RNN, Backpropagation, Through Time (BTT), Vanishing and Exploding Gradients, Truncated BTT, Long Short Term Memory: Selective Read, Selective write, Selective Forget, Gated Recurrent Unit, Application of RNN (for example credit card Fraud detection, rainfall predictions, speech recognition etc)		
6	**Self-Study Topics**		**05**
	Applications of Deep Learning Large-Scale Deep Learning, Computer Vision, Speech Recognition, Natural Language Processing, Other Applications		
		Total	**42**

Laboratory Component

Sr. No	Title of the Experiment
1	Build a deep neural network model starting with linear regression using a single variable and using multiple variables.
2	Write a program to convert speech into text and vice versa
3	Write a program for Time-Series Forecasting with the LSTM Model.
4	Write a program to implement deep learning Techniques for image segmentation
5	Write a program for object detection using image labeling tools
6	Write a program to predict a caption for a sample image using CNN.
7	Write a program for character recognition using RNN and compare it with CNN.
8	Write a program to detect Dog image using YOLO Algorithm
9	Write a program to develop Autoencoders using MNIST Handwritten Digits
10	Write a program to develop a GAN for Generating MNIST Handwritten Digits

Textbooks:

1 Ian Goodfellow, Yoshua Bengio, Aaron Courville. ―Deep Learning‖, MIT Press Ltd, 2016
2 Li Deng and Dong Yu, ―Deep Learning Methods and Applications‖, Publishers Inc.
3 Satish Kumar "Neural Networks A Classroom Approach" Tata McGraw-Hill.

4 JM Zurada ―Introduction to Artificial Neural Systems‖, Jaico Publishing House
5 M. J. Kochenderfer, Tim A. Wheeler. ―Algorithms for Optimization‖, MIt Press.

References:

1 Buduma, N. and Locascio, N., ―Fundamentals of deep learning: Designing next-generation machine intelligence algorithms" 2017. O'Reilly Media, Inc.".
2 François Chollet. ―Deep learning with Python ―(Vol. 361). 2018 New York: Manning.
3 Douwe Osinga. ―Deep Learning Cookbook‖, O'REILLY, SPD Publishers, Delhi.
4 Simon Haykin, Neural Network- A Comprehensive Foundation- Prentice Hall International, Inc
5 S.N.Sivanandam and S.N.Deepa, Principles of soft computing-Wiley India

Useful Links

1 https://nptel.ac. https://deeplearning.cs.cmu.edu/S21/index.html
2 http://www.cse.iitm.ac.in/~miteshk/CS6910.html
3 https://nptel.ac.in/courses/106/106/106106184/
4 https://www.deeplearningbook.org/

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	SE	TE	L	T	P	Total
TE	Design Thinking	3	0	2	4	9	3	0	1	4
		Examination Scheme								
		Component	ISE		MSE		ESE			Total
MC514		Theory	75		75		150			300
		Laboratory	100		--		100			100

Pre-requisite Course Codes, if any.	User Interaction Design
Course Objective: To understand the core principles and foundational concepts in design thinking. To create user centric mindset that drives innovations and provides solutions that address real world problem to create impactful results.	
Course Outcomes (CO):*At the End of the course students will be able to*	
MC514.1	Understand the principles and foundations of design thinking
MC514.2	Foster a user-centric mindset to drive innovation using design thinking
MC514.3	Design solutions that address real-world problem
MC514.4	Create the prototype for proposed design.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
MC514.1	2	2	-	-	-	-	-	-	-	-
MC514.2	-	-	3	2	-	-	-	-	-	-
MC514.3	-	-	3	-	-	-	-	1	1	1
MC514.4	-	-	3	2	-	-	-	1	-	1

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create ✓**

Theory Component

Module No.	Topics	Ref.	Hrs.
1	**Introduction** Why Design? Four Questions, Ten Tools – Principles of Design Thinking, The process of Design Thinking ,How to plan a Design Thinking project	1,2	6
2	**Understand, Observe and Define the Problem** Search field determination, Problem Clarification, Understanding of the problem, Problem Analysis , Reformulation of the problem ,Observation Phase , Empathetic design , Tips for Observing , Methods for Empathetic Design Point of View Phase , Characterization of the target group , Description of customer needs.	1,2	10
3	**Ideation and Prototyping** Ideate Phase, The creative process and creative principles, Creativity techniques, Evaluation of Ideas, Prototype Phase ,Lean Start-up Method for Prototype Development ,Visualization and Presentation techniques. Use of Diagrams and Maps in Design Thinking – Empathy map. Affinity diagram, mind map, journey map, combining ideas into complex innovation concepts.	1,2	10
4	**Testing and Implementation** Test Phase, Tips for interviews, Tips for surveys, Kano Model, DesirabilityTesting, How to Conduct workshop, Requirements for the space , Material requirements , Agility for Design Thinking	1.2	7
5	**Future** Design Thinking meets the corporation, The New Social Contract, Design Activism, Designing Tomorrow. Design Thinking in IT : Design Thinking to Business Process modelling , Agile in Virtual collaboration environment , Scenario based Prototyping .	1.2	9
6	**Self-Study Topics** Case Study of Airbnb, Pepsico, few case studies from Stanford University and CMU		
		Total	**42**

Laboratory Component

Sr. No	Title of the Experiment
1	Redesigning a Transportation System for a Smart City using stakeholder Mapping.
2	Enhancing User Safety in a Medical Device using Usability Testing and Human Factors Analysis
3	Designing a Sustainable Packaging Solution for a Product using Life Cycle Assessment and Material Exploration
4	Improving Energy Efficiency in a Building using Energy Monitoring and Retrofit Analysis
5	Creating an Autonomous Drone for Agricultural Monitoring using Rapid Prototyping and Field Testing
6	Redesigning a Public Space for Community Engagement using Observation and Participatory Design
7	Developing a Renewable Energy Microgrid System using System Modeling and Simulation
8	Designing an Augmented Reality (AR) Training Tool for Industrial Maintenance using User Research and Prototyping
9	Enhancing education system in an Urban Area using Data Analytics and Sensor Technology
10	Creating a User-Friendly Interface for Industrial Automation Equipment using User-Centered Design and Usability Testing

Text Books:

[3] Christian Mueller-Roterberg, Handbook of Design Thinking – Tips & Tools for how to design thinking, Nov..2018 ,paperback.
[4] Designing for Growth: a design thinking tool kit for managers By Jeanne Liedtka and Tim Ogilvie. ,Columbia Business School publishing, 2011.
[5] Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation by Tim Brown, HarperCollins e-books; 1st edition (16 September 2009)

REFERENCES:

[5] Johny Schneider, "Understanding Design Thinking, Lean and Agile", O'Reilly Media, 2017.
[6] Roger Martin, "The Design of Business:Why Design Thinking is the Next Competitive Advantage", Harvard Business Press, 2009.
[7] Hasso Plattner, Christoph Meinel and Larry Leifer (eds), "Design Thinking: Understand-Improve –Apply". Springer, 2011.

WEB REFERENCES:

[8] http://ajjuliani.com/design-thinking-activities/
[9] https://venturewell.org/class-exercises

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	SE	TE	L	T	P	Total
TE	Total Experience Design	3	0	2	4	9	3	0	1	4
MC515		Examination Scheme								
		Component	ISE		MSE		ESE		Total	
		Theory	75		75		150		300	
		Laboratory	50		--		50		100	

Pre-requisite Course Codes	Software Engineering	
Course Objectives	Total Experience Design (TXD) involves covering various aspects of design that consider the holistic user experience. This includes not only the interaction with products but also the entire journey of the user, including pre-use, use, and post-use experiences. This course provides an opportunity to learn and apply User experience design principles in day-to-day life. Learners will understand and identify the steps in the life cycle template of UX Design. The laboratory experiments are designed to practice the concepts and to adopt the systematic approach for gaining user experience via interface design using various UX tools. It also covers also covers Total experience design concept which is current buzz in the market.	
At the End of the course students will be able to		
Course Outcomes	MC515.1	Analyze the UX design life cycle and its process for users.
	MC515.2	Evaluate the UX design process for the given scenario
	MC515.3	Analyse the Total Experience Design process for users
	MC515.4	Evaluate total experience design for the given scenario.
	MC515.5	Create real-life applications with an end-to-end understanding of User experience practices.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
MC515.1	-	2	2	1	1	-	-	-	1	-
MC515.2	-	2	2	2	1	-	-	-	-	-
MC515.3	-	2	2	2	1	-	-	-	1	-
MC515.4	-	-	1	2	1	-	-	-	-	-
MC515.5	-	2	2	2	1	-	-	1	-	-

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create ✓

Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**The UX Design Process – Life Cycle and Understanding Users**	1	10
	1.1	What is UX (User Experience), A UX process lifecycle template, The system complexity space, Meet the user interface team. **Contextual Inquiry:** Introduction, the system concept statement, User work activity gathering. **Contextual analysis:** Introduction, Creating and managing work activity notes, Constructing your WAAD (Work Activity Affinity Diagram). **Extracting Design Interaction requirements:** Formal Requirements Extraction. **Design Informing Model:** User Model (Social Model), Usage Model (Flow Model).		
2		**The UX Design Process- Designing, Prototyping and Evaluation**	1,3,5	8
	2.1	Design Paradigm, Design thinking, Design perspective, User personas, Ideation, Sketching, Mental Models and Conceptual Design, Storyboards, Wireframes. Fidelity of Prototype, UX Evaluation and Improve UX Goals, Metrics and Targets, UX Evaluation Techniques- Formative vs Summative		
3		**Total Experience Design (TXD)**		
	3.1	Definition and importance of TXD, Components of TXD (User Experience, Customer Experience, Employee Experience, etc.), Understanding Customer, Employee and Multi Experience in detail. Case studies of successful TXD implementations		8
4		**Service Design, Emotional Design and Behavorial Design**		

	4.1	Introduction to Service Design, Designing for touchpoints and service ecosystems, Service blueprinting, Measuring and evaluating service experiences, Understanding emotional responses in design, Techniques for creating emotional connections , Ethical considerations in emotional and behavioral design, Principles of accessible design,Techniques for designing inclusive experiences.		8
5		**Future Trends in Total Experience Design**		8
	5.1	Emerging technologies and their impact on TXD (AR, VR, AI), The role of data and analytics in TXD, Sustainable design practices, The future of work and experience design.		
5		**Self Study Topics**		
	6.1	UX Method for Agile Development: Introduction, Basics of agile SE methods, drawbacks of agile SE methods from UX perceptive.		
			Total	42

Laboratory Component,

Sr. No.	Title of the Experiment
1	To Study of open source UX tools (Justinmind Prototype, Pidoco, Marvel Prototype) and create UX design for a given problem definition.
2	Design Mobile/Web UI for your own Travelling agent considering adding map and localization features along with descriptions if required. (e.g, Make my Trip,Tripadvisor,thrillophilia etc.). Use Figma's constraints and auto-layout features to make elements responsive.
3	Design a Map-based UI(Web User) for Mumbai Dabbawalas with localization feature.
4	Pick an app that you use on a daily basis (eg. facebook, gmail, whatsapp, zomato, etc). suggest improvements and create the heuristic report using Nielsen's Heuristic and accessibility tool (e.g., WAVE, Axe, Lighthouse) (15) Use accessibility tools to identify issues related to usability for people with

	disabilities. (16) Document findings and categorize them by severity. (17) Discuss in small groups how to address the identified issues. (18) Present recommendations for making the product more accessible.
5	Evaluate the accessibility of a digital product, suggest improvements and create the heuristic report using Nielsen's Heuristic and accessibility tool (e.g., WAVE, Axe, Lighthouse) [6] Choose a website to evaluate. [7] Use accessibility tools to identify issues related to usability for people with disabilities. [8] Document findings and categorize them by severity. [9] Discuss in small groups how to address the identified issues. [10] Present recommendations for making the product more accessible.
6	Design UI for students to teach mathematics in rural areas to students. Incorporate micro-interactions such as hover effects, loading animations, and transitions between screens.
7	Design UI for students to sell the products of farmers directly to consumers. Design reusable components (e.g., buttons, forms, cards) and organize them in the design system.
8	Analyze a product's emotional design elements and their impact on user experience. [10] Choose a product and identify its key emotional design elements (e.g., color scheme, shapes, interactions). [11] Analyze how these elements evoke emotions and contribute to the overall user experience. [12] Discuss in small groups how changing certain elements might alter the user's emotional response. [13] Present findings and suggest design improvements to enhance emotional engagement.

9	Create a service blueprint to visualize the front-stage and back-stage processes of a service. (6) Choose a service to blueprint (e.g., dining experience at a restaurant). (7) Identify all touchpoints and interactions between the user and the service. (8) Map out the front-stage (customer-facing) activities and back-stage (behind-the-scenes) processes. (9) Use sticky notes to represent each touchpoint and process. (10) Discuss how the blueprint can help identify inefficiencies and opportunities for improvement.
10	Design UI for analysis of the number of children suffering from juvenile diabetic children in India. The design aims at providing solutions for improving quality treatment and making the treatment affordable.

Note: All the experiments need to be tested for usability. The problem statement for any experiment can be changed by the instructor during the laboratory with different examples.

References:

[1] The UX Book (1st Edition) by Rex Hartson and Pardha Pyla, MK Publication, 2012.
[2] A Project Guide to UX Design: For user experience designers in the field or in the making (2nd Edition) by Russ Unger and Carolyn Chandler, O'Reilly, Series Editor, 2012.
[3] UI Design: Key to captivate user understanding (1st Edition) by Jain, Kalbande, SybGen Publications, 2021.
[4] Service Design: From Insight to Implementation" (1st Edition) ,Andy Polaine, Lavrans Løvlie, Ben Reason, Rosenfeld Media, 2013.
[5] "Interaction Design: Beyond Human-Computer Interaction" by Jenny Preece, Helen Sharp, and Yvonne Rogers, 5th Edition, Wiley publication.

Online Web Resources for conceptualizing and practicing the UX tools as:
[w1] https://www.sketch.com/
[w2] https://www.figma.com/
[w3] https://www.adobe.com/in/products/illustrator.html
[w4] https://pencil.evolus.vn/
[w5] https://www.lucidchart.com/pages/
[w6] https://www.invisionapp.com/
[w7] https://xtensio.com/

[w8] https://miro.com/
[w9] https://uxpressia.com/
[w10] https://wave.webaim.org/

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	SE	TE	L	T	P	Total
PE	Network and Information Security	3	0	2	4	9	3	-	1	4
MC516		Examination Scheme								
		Component	ISE		MSE		ESE			Total
		Theory	75		75		150			300
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	
Course Objective: To learn fundamental concepts of Network and Information security.	
Course Outcomes (CO): ***At the End of the course students will be able to***	
MC516.1	Understand basics of security and cryptography
MC516.2	Apply cryptographic algorithms and protocols to maintain computer security
MC516.3	Understand and Use the various authentication mechanisms and concepts of hashing.
MC516.4	Analyze internet security protocols
MC516.5	Understand VPN,Firewall and IDS

CO-PO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
MC516.1	3		-	-	-	-	-	-	-	-
MC516.2	3	3	2	2	-	-	-	-	1	-
MC516.3	3	1	-	-	-	-	-	-	-	-
MC516.4	2	2	-	-	-	-	-	-	1	-
MC516.5	3	-	-	-	-	-	-	-	-	-

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	**Understand**	**Apply**	**Analyze ✓**	**Evaluate**	**Create**

Theory Component

Module No.	Topics	Ref.	Hrs.
1	**Introduction** Introduction to Security in Networks,Characteristics of Networks, Security principles, Intrusion,Kinds of security breaches, Plan of attack,Points of vulnerability, Methods of defense, Control measures , Effectiveness of controls,risk and threat analysis,types of attack	1,2	6
2	**Basic of Cryptography** Symmetric Cipher Model, Cryptography, Cryptanalysis and Attacks; Substitution and Transposition techniques,Symmetric and Asymmetric Cryptography, Stream ciphers and block ciphers, Block Cipher structure	1,2	4
3	**Secret key Cryptography and Public key Cryptography** Data Encryption standard (DES) with example, strength of DES, Design principles of block cipher, AES with structure, its transformation functions, key expansion, example and implementation ,Schemes to encrypt large messages: ECB, CBC, OFB, CFB, Multiplication Encryption DES,Need and Principles of Public Key Cryptosystems, RSA Algorithm,Key Distribution and Management, Diffie-Hellman Key Exchange,Digital Signatures	1,2,3	10
4	**Hash Functions, Message Digest and Authentication standards** **Hash functions & message digest:** MD2,MD4 &MD5 Comparison,SHA,HMAC **Authentication and Standards**:Types of Authentication (Password, address, cryptography, smart cards, biometric, mutual)KDC working and Multi domain KDC,KerberosV5: names, delegation of rights, ticket lifetime , key version, kerberosV4 vs Kerberos V5,PKI: introduction, PKI trust models, PKI & X.509	1,2,3	10
5	**Internet Security Protocols** Web Security threats and approaches,SSL,SET,Email Security- PGP, S/MIME,IPSec- AH, ESP,Transport layer security, HTTPS and SSH	1,2	6
6	**VPN, IDS and Firewall** IDS-types and detection models, IDS features, Honeypot,Firewall-Introduction, Types,Virtual Private Network: Introduction, VPN Protocols	1,2	6
		Total	**42**

Laboratory Component

Sr. No	Title of the Experiment
1	Implement Caesar cipher encryption-decryption
2	Implement Playfair cipher encryption-decryption
3	To implement Simple DES or AES
4	Implement Diffie- Hellman Key exchange Method.
5	Implement RSA encryption-decryption algorithm.
6	Write a program to generate SHA-1 hash.
7	Implement a digital signature algorithm.
8	Perform various encryption-decryption techniques with cryptool
9	Perform Email tracing using any open source tool
10	Study and use the Wireshark for the various network protocols.

Text Books:

[1]W. Stallings, Cryptography and Network Security Principles and practice, Seventh Edition, Pearson Education Asia, 2017.
[2] AtulKahate, Cryptography and Network Security, Third Edition, McGraw Hill, July 2017
[3] Behrouz A. Forouzan and Debdeep Mukhopadhyay, Cryptography and Network Security, third edition, Tata McGraw Hill, 2016

Reference Books:

[3]Michael Stinson. D. Cryptography: Theory and Practice, third edition, Chapman & Hall/CRC, 2010
[4] Modern cryptography: theory & practice, Wembo Mao, Pearson Education; First Edition, 2004.

Bharatiya Vidya Bhavan's
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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	SE	TE	L	T	P	Total
TE	Cyber Security and Digital Forensic	3	0	2	4	9	3	0	1	4
		Examination Scheme								
		Component	ISE		MSE		ESE			Total
MC517		Theory	75		75		150			300
		Laboratory	100		--		100			100

Pre-requisite Course Codes, if any.	Network Security& Information Security
Course Objective: To able to analyze issues and use various tools and methods to understand hoe cyber criminals facilitate cyber crime activities. To understand legal framework and laws related to cyber crime. To analyze forensic techniques to invesitage electronic devices.	
Course Outcomes (CO): ***At the End of the course students will be able to***	
MC517.1	Analyze the issues and challenges faced due to cyber crime.
MC517.2	Evaluate various tools and methods used in cybercrime
MC517.3	Explain the laws for various cyber crime
MC517.4	Analyze forensics of Computer and Handheld Devices for investigation.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
MC517.1	-	2	-	-	-	-	2	1	1	-
MC517.2	-	2	2	2	-	-	2	2	1	-
MC517.3	-	2	-	-	-	-	3	1	-	-
MC517.4	1	2	2	2	-	-	3	2	1	-

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create ✓**

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Theory Component:

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Cyber offenses & Cybercrime: Issues and challenges**	1,2,3	**8**
	1.1	Cybercrime definition and origins of the world		
	1.2	Classifications of cybercrime		
	1.3	How criminals plan the attacks, Social Engineering		
	1.4	Cyber stalking, Botnets,		
	1.5	Attack vector		
	1.6	Credit Card Frauds in Mobile and Wireless Computing Era		
	1.7	Attacks on Mobile/Cell Phones, Ransomware		
	1.8	Web Treats for Organizations: The Evils and Perils		
	1.9	Best practices with social media marketing tools		
2		**Tools and Methods Used in Cybercrime**	1,2	**10**
	2.1	Proxy Servers and Anonymizers		
	2.2	Password Cracking		
	2.3	Key loggers and Spywares		
	2.4	Virus and Worms		
	2.5	Steganography		
	2.6	DoS, DDoS Attacks		
	2.7	SQL Injection		
	2.8	Buffer Over Flow		
	2.9	Attacks on Wireless Networks		
	2.10	Phishing (Methods,Techniques,Countermeasures)		
	2.11	Identity Theft (Types,Techniques,Countermeasures)		
3		**Cybercrimes and Cyber security**	1,2,10	**8**
	3.1	The Legal Perspectives Why do we need Cyber law: The Indian Context		
	3.2	Positive and Weak areas of ITA 2000		
	3.3	Information Security Standard compliances: SOX, GLBA, HIPAA, ISO.		
	3.4	International Laws: E-Sign, CIPA and COPPA		
4		**Understanding Computer Forensics**	1,9	**10**
	4.1	Historical background of cyber forensic		
	4.2	Need for computer forensic		
	4.3	Cyber forensic and Digital Evidence, Forensic Analysis of E-mail		
	4.4	Digital Forensic life cycle.		

	4.5	Chain of custody, network forensic		
	4.6	Approaching a forensic Investigation		
	4.7	Computer Forensic and Steganography		
	4.8	Relevance of OSI 7 layer model to computer forensic		
	4.9	Forensic and social networking sites: The security/ privacy threats		
5		**Forensics of Hand-held devices**	1,8	**6**
	5.1	Mobile Phone Forensics, Printer and scanner forensics, Smartphone.		
	5.2	Challenges in Forensics of the digital Images and Still Camera.		
	5.3	Toolkits for Hand-Held Device Forensics(EnCase,Forensic card reader,MOBILedit)		
	5.4	Organizational Guidelines on Cell Phone Forensics.		
			Total	**42**

Laboratory Component

Sr. No	Title of the Experiment
1	Performing Man-in-the-Middle Attack using Wireshark & Ettercap.
2	Performing SQL injection and suggest its countermeasures. A. Manual SQL Injection, John the Ripper. B. Automate SQL Injection with Sql Map.
3	Demonstrate Password Cracking with Hashcat.
4	Demonstrate Social Engineering attack and suggest its countermeasures.
5	Demonstrate the use of nmap tool for the given scenario.
6	Implement steganography and suggest its countermeasures.
7	Demonstrate email spoofing and phishing attack and suggest its countermeasures.
8	Demonstrate to extract and analyze metadata from digital files.
9	Recover deleted files from a storage device.
10	Demonstrate and analyze E-mail forensics

Recommended Books:

[1] Nina Godbole, SunitBelapure, *"Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives",* Wiley India, New Delhi ,2012.

[2] Nina Godbole "Information Systems Security", Wiley India, New Delhi ,2008

[3] Dan Shoemaker, William Arthur Conklin, Wm Arthur Conklin *"Cybersecurity: The Essential Body of Knowledge"*, Cengage Learning,2011.

[4] Edward Amoroso *"Cyber Security",* Silicon Press, First Edition ,2012.

[5] Kennetch J. Knapp "Cyber Security &Global Information Assurance", Information Science Publishing, 2009.

[6] Cory Altheide and Harlan Carvey , "Digital Forensics with open source tools" , ISBN: 978-1-59749-586 8,Elsevier Publications, April 2011

[7] Eoghan Casey ,"Digital Evidence and Computer crime 3rd Edition: Forensics Science, Computers and the Internet", 2011

[8] Marjie T. Britz, "Computer Forensic and Cyber Crime: An Introduction", 3rd Edition , 2013

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	SE	TE	L	T	P	Total
PE	DevOps	3	0	2	4	9	3	0	1	4
		Examination Scheme								
		Component	ISE		MSE		ESE			Total
MC518		Theory	75		75		150			300
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	Web Technology Lab, Linux fundamentals
Course Objective: This course is designed to provide the core knowledge necessary to understand DevOps concepts, its principles and practices and tools.	
Course Outcomes (CO): ***At the End of the course students will be able to***	
MC518.1	Understand the basics of DevOps.
MC518.2	Utilize GIT to keep track of different versions of the source code.
MC518.3	Build continuous integration steps using Jenkins.
MC518.4	Develop containers using Docker
MC518.5	Make use of Kubernetes for Orcherstration.
MC518.6	Make use of Security testing for continuous monitoring.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
MC518.1	2	-	-	-	-	-	-	-	-	-
MC518.2	2	2	2	3	2	-	-	-	2	-
MC518.3	2	2	2	3	2	-	-	-	2	-
MC518.4	2	2	2	3	2	-	-	-	2	-
MC518.5	2	2	2	3	2	-	-	-	2	-
MC518.6	2	2	2	3	2	-	-	-	2	-

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create ✓**

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Theory Component

Module No.	Topics	Ref.	Hrs.
1	**Introduction to DevOps**	1,2,3	4
	Introduction to DevOps: Define the concept of DevOps, explain its origins, and describe its benefits and challenges., DevOps Delivery Pipeline		
2	**Version Control using Git**	1,2.3	6
	Version Control with Git –version control basics, Git fundamentals, Installation of Git, Common commands in Git, Branching and Merging in Git, Git workflows		
3	**Continuous Integration using Jenkins**	1,2.3	6
	Build Automation, what is CI, Why CI is Required, CI tools, Introduction to Jenkins (With Architecture), jenkins workflow,jenkins master slave architecture, Jenkins Pipelines, Pipeline Basics – Jenkins Master Node, Agent, and Executor, Freestyle Projects & Pipelines, Jenkins for Continuous Integration, Create and Manage Builds, User Management in Jenkins, Schedule Builds, Launch, Builds on Slave Nodes.		
4	**Containerization using Docker**	1,2.3	10
	Introducing Docker, Understanding images and containers,Running Hello World in Docker, Docker Hub, Introduction to Container,Container Life Cycle,Sharing and Copying Base Image,Docker File Working with containers		
5	**Orchestration using Kubernetes**	1,2.3	8
	Revisiting Kubernetes, Cluster Architecture,Spinning up a Kubernetes Cluster on Ubuntu VMs, Exploring your Cluster Understanding YAML,Creating a Deployment in Kubernetes using YAML,Creating a Service in Kubernetes,Installing Kubernetes Dashboard,Deploying an App using Dashboard,Using Rolling Updates in Kubernetes,Containers and Container Orchestration		
6	**Security Testing and Continuous Monitoring with Nagios**	4	8
	Security Testing- Auditing,Analyzing Vulnerabilities OpenVAS, Burpsuite, OWASP-ZAP Continuous Monitoring, Introduction to Nagios, Installing Nagios, Nagios Plugins(NRPE) and Objects, Nagios Commands and Notification		
7	**Self-Study Topics**		
	Microservices, virtual machine configurations using Vagrant, container configuration using Docker, container deployment/orchestration using Docker Swarm and Kubernetes, automated deployments using Terraform, DevOps Cloud		

Total	**42**

Laboratory Component

Sr. No	Title of the Experiment
1	Setup of Linux OS, DevOps tools and working with Linux commands
2	Version control using git
3	Continuous Integration using Jenkins
4	Configuration Management using Ansible
5	Containerization using Docker
6	Orchestration using Kubernetes
7	Automated Testing using Selenium
8	Continuous monitoring using NagiOS, Prometheus
9	Provisioning using Terraform
10	DevOps Cloud
11	Hosting Website or any Docker application on AWS EC2

Text Books:

[1] Joyner Joseph, Devops for Beginners: Devops Software Development Method Guide for Software Developers and It Professionals, 1st Edition, Mihails Konoplovs, 2015.
[2] Alisson Machado de Menezes., Hands-on DevOps with Linux, 1st Edition, BPB Publications, India, 2021.

Reference Books:

[3] Gene Kim, Jez Humble, Patrick Debois, John Willis. The DevOps Handbook, 1st Edition, IT Revolution Press, 2016.
[4] Verona, Joakim, Practical DevOps, 1st Edition, Packt Publishing, 2016

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	SE	TE	L	T	P	Total
PE	Explainable Artificial Intelligence	3	0	2	4	9	3	0	1	4
		Examination Scheme								
		Component	ISE		MSE		ESE			Total
MC519		Theory	75		75		150			300
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	AI, Machine Learning
Course Objective: This course is designed to understand interpretability , explainability and attribution methods for AI models	
Course Outcomes (CO): ***At the End of the course students will be able to***	
MC519.1	Understand the concept and importance of XAI and its applications in various domains.
MC519.2	Explore the various XAI techniques and tools used for tabular, image and text dataset.
MC519.3	Gain practical experience with XAI frameworks..
MC519.4	Evaluate the trade-offs between explainability and accuracy.

CO-PO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
MC519.1	3	3	-	-	-	-	-	-	-	-
MC519.2	3	3	-	-	-	-	-	-	1	1
MC519.3	-	-	-	3	-	-	-	-	1	1
MC519.4	-	3	-	-	-	-	-	-	-	-

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	**Understand**	**Apply**	**Analyze ✓**	**Evaluate**	**Create**

Theory Component

Module No.	Topics	Ref.	Hrs.
1	Introduction to Explainable Artificial Intelligence	1,2	4
	Why Explainable AI?, What Is Explainable AI?, Who Needs Explainability?, Challenges in Explainability, Types of explanation,		
2	Explainability for Tabular Data	1,2	12
	Permutation Feature Importance: Permutation Feature Importance from Scratch, Permutation Feature Importance in scikit-learn Shapley Values: SHAP (Shapley Additive exPlanations), Visualizing Local Feature Attributions, Visualizing Global Feature Attributions, Interpreting Feature Attributions from Shapley Values, Managed Shapley Values Explaining Tree-Based Models: From Decision Trees to Tree Ensembles, SHAP's TreeExplainer Partial Dependence Plots and Related Plots: Partial Dependence Plots (PDPs), Individual Conditional Expectation Plots (ICEs)		
3	Explainability for Image Data	1,2	12
	Integrated Gradients (IG), Choosing a Baseline, Accumulating Gradients, Improvements on Integrated Gradients, (Extremal regions with attributions importance) XRAI, How XRAI Works, Implementing XRAI, Grad-CAM, How Grad-CAM Works, Implementing Grad-CAM LIME: How LIME Works, Implementing LIME, Guided Backpropagation and Guided Grad-CAM, Guided Backprop and DeConvNets, Guided Grad-CAM		
4	Explainability for Text Data	1.2	6
	Overview of Building Models with Text: Tokenization, Word Embeddings and Pretrained Embeddings, LIME, How LIME Works with Text, Gradient x Input, Intuition from Linear Models From Linear to Nonlinear and Text Models		
5	Layer Integrated Gradients:	1.2	8
	A Variation on Integrated Gradients, Layer-Wise Relevance Propagation (LRP), How LRP Works, Deriving Explanations from Attention, Which Method to Use?, Language Interpretability Tool		
6	Self-Study Topics		
	Building with Explainability in Mind, The ML Life Cycle AI Regulations and Explainability, What to Look Forward To in Explainable AI, Natural and Semantic Explanations, Interrogative Explanations, Targeted Explanations		
		Total	**42**

Laboratory Component

Sr. No	Title of the Experiment
1	To implement a simple decision tree model for predicting whether a patient has diabetes based on their medical information. Note : students could implement decision trees using a dataset, visualize the decision tree, and explain the results
2	Feature Importance: To implement SHAP algorithm to calculate the feature importance on a given data set. Note:students could analyze a dataset and calculate the feature importance using an algorithm such as permutation importance or SHAP (SHapley Additive exPlanations), and explain the results.
3	Non linear relationship between features and predicted model: Interpretation and explanation of ML models [marginal effect of a single feature on the predicted outcome while holding all other features constant] To implement PDP(partial dependance plot) to calculate the feature importance on a given data set. Note: students could perform sensitivity analysis on a trained model to understand how the output varies with changes in the input features.
4	Non linear relationship between features and predicted model: Interpretation and explanation of ML models To implement ICE (Individual Conditional Expectation Plots) to calculate the feature importance on a given data set.[conditional effect of a single feature on the predicted outcome for each individual sample in a dataset] Note: students could perform sensitivity analysis on a trained model to understand how the output varies with changes in the input features.
5	To implement an IG algorithm for attributions analysis for a given problem statement.
6	To implement the XRAI algorithm for attributions analysis for a given problem statement.
7	To implement a grad-CAM method to generate class activation maps for a given problem statement.

8	Local Interpretable Model-agnostic methods: To implement LIME to explain the predictions of a given problem statement. Note: students could use model-agnostic methods such as LIME (Local Interpretable Model-Agnostic Explanations) or Anchors to explain the predictions of a machine learning model
9	To implement LIME to analyze text data, such as social media posts or customer reviews, and classify them into different categories.
10	To study LRP and demonstrate LIT by Google for interactive visualization, interpretation and understanding NLP models.

Text Books:

1. Explainable AI for Practitioners: Designing and Implementing Explainable ML Solutions 1st Edition Michael Munn, David Pitman OReilly Media, Inc 2022
2. Explainable Artificial Intelligence: An Introduction to Interpretable Machine Learning 1st Edition Uday Kamath , JohnLiu Springer Link 2021
3. Explainable AI: Interpreting, Explaining and Visualizing Deep Learning 1st Edition Wojciech Samek, Grégoire Montavon, Andrea Vedaldi, Lars Kai Hansen, Klaus-Robert Müller Springer Link 2019

Reference Books:

1. Interpretable Machine Learning: A Guide for Making Black Box Models Explainable 1st Edition Christoph Molnar, published Springer 2019
2. Explainable AI: Interpreting, Explaining and Visualizing Deep Learning 1st Edition KonstantinosG. Margaritis and Evangelos N. Daskalakis, published Wiley 2020
3. Explainable AI in Healthcare: An Interdisciplinary Approach 1st Edition Kristin H. Jarman and Julia A. Lane Springer 2021
4. XAI - Explainable Artificial Intelligence: Foundations, Methods, and Applications 1st Edition Fatma Bouali and Sihem Mesnager Springer 2020
5. Explainable AI: Interpreting, Explaining and Visualizing Deep Learning 1st Edition Kalyan Veeramachaneni, published by O'Reilly Media 2021

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	SE	TE	L	T	P	Total
PE	Cloud Computing	3	0	2	4	9	3	0	1	4
		Examination Scheme								
		Component	ISE		MSE		ESE			Total
MC520		Theory	75		75		150			300
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	
Course Objective: To learn fundamentals of cloud computing.	
Course Outcomes (CO): ***At the End of the course students will be able to***	
MC520.1	Demonstrate understanding of cloud computing fundamentals, including service and deployment models, key technologies, and their benefits and limitations through real-world applications.
MC520.2	Apply virtualization and containerization technologies such as KVM, Docker, and Kubernetes to build scalable and efficient cloud infrastructure.
MC520.3	Analyze and select appropriate cloud services and platforms (AWS, Azure, GCP, OpenStack) based on cost, performance, and security considerations.
MC520.4	Design and implement cloud-native applications and DevOps workflows using tools such as Ansible, AWS EC2, S3, VPC, ECS, EKS for real-time deployment and automation

CO-PO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
MC520.1	3	3	-	-	-	-	-	-	-	1
MC520.2	3	3	-	-	-	-	-	-	-	-
MC520.3	-	-	-	3	-	-	-	-	-	-
MC520.4	-	3	-	-	-	-	-	-	1	1

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	**Understand**	**Apply**	**Analyze ✓**	**Evaluate**	**Create✓**

Theory Component

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Module No.	Topics	Ref.	Hrs.
1	**Introduction to Cloud Computing** Trends in computing - Grid Computing, Cluster Computing, Distributed Computing, Utility Computing, Cloud Computing Defining a Cloud ,Vision of Cloud, Cloud Computing Reference Model, Characteristics and benefits, Challenges of Cloud, Distributed computing principles, Business drivers for cloud adoption	1,2	6
2	**Virtualization in Cloud** Introduction & benefit of Virtualization, Implementation Levels of Virtualization, Types: Full and para virtualization Taxonomy of virtualization techniques - Execution Virtualization, Virtualization and cloud computing, Pros and cons of virtualization	1,2,3	9
3	**Cloud Architecture** Cloud Types: Private Cloud, Public cloud,Hybrid cloud, community cloud. Cloud Computing Service Models (Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Software as a Service (SaaS), Anything as a Service (XaaS)) Service model comparison, Service model selection criteria, Responsibilities in each service model	1,2,4	9
4	**Cloud Security and DevSecOps** Cloud security challenges, Shared responsibility model, DevSecOps principles, Security as Code, Static Application Security Testing (SAST), Dynamic Application Security Testing (DAST), Vulnerability Assessment and Penetration Testing (VAPT)	1.2	9
5	**Synchronization in cloud environment** Clock synchronization protocols in cloud data centers, Leader Election protocols in cloud ,Gossip Protocols and its types	3	9
6	**Self-Study Topics** Multi-Cloud Strategy and Future Trends, Multi-cloud architecture design, Green Cloud Computing, Multi-cloud management tools, Multi-cloud security considerations, AI/ML and cloud convergence		
		Total	42

Laboratory Component

Sr. No	Title of the Experiment
1	Ubuntu: Creating and Running Virtual Machines on Hosted Hypervisors (Virtual Box, KVM, QEMU)
2.	Ubuntu: Development of application using Docker and Docker Compose
3.	Ubuntu: Development of Automation using Ansible
4.	Ubuntu: Development of application using Kubernetes using Minikube
5.	Ubuntu: Testing of application using Kubernetes using Minikube-Testing
6	AWS: To build and deploy EC2 instance, S3 / EBS, Cloud Watch, Cloud Trail in AWS, Simple Notification System, Lambda function
7	AWS: Building and Deploying Web Applications using AWS Elastic Beanstalk
8	AWS: Build the pipeline of jobs using jenkins, create a pipeline script to deploy an application
9	AWS: Design an architecture which can automatically scale up and down based on traffic and is de-coupled for components like Database, webapp etc. using Load Balancer
10	Google Cloud: Deploying a Java Application to Google App Engine (GCP)

Reference Books:

[1] Distributed and Cloud Computing by Kai Hwang Geoffrey C. Fox Jack J. Dongarra, First Edition, Morgan Kofmann
[2] Cloud Computing: A Hands on Approach by Harshdeep Bahgha and Vijay M. https://hands-on-books-series.com/cloud.html
[3] Cloud Computing Solutions Architect by Harshdeep Bahgha and Vijay M.
[4] Cloud Computing: Concepts, Technology & Architecture by Thomas Erl
[5] AWS Certified Solutions Architect - Professional Study Guide by Brett McLaughlin & Jorge Acetozi
[6] Google Cloud Platform for Architects by Vitthal Srinivasan
[7] Microsoft Azure: Planning, Deploying, and Managing the Cloud by Marshall Copeland
[8] The Definitive Guide to Container Security by Gareth Baruch, Dave Dukinfield, and Mohit Bhasin, Wiley Publishing.
[9] Additional portion: Cloud Migration Strategies and Cloud Programming Environment

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	SE	TE	L	T	P	Total
PE	Soft Computing	3	0	2	4	9	3	0	1	4
		Examination Scheme								
		Component	ISE		MSE		ESE			Total
MC521		Theory	75		75		150			300
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	Mathematics, AI
Course Objective: To learn fundamentals of soft computing	
Course Outcomes (CO): ***At the End of the course students will be able to***	
MC521.1	Understand the difference between learning and programming and explore practical applications of Neural Networks (NN).
MC521.2	Design Neural Networks
MC521.3	Analyze the applications which can use fuzzy logic
MC521.4	Understand the basics of genetic algorithm, use of GA operators and its applications..

CO-PO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
MC521.1	3	3	-	-	-	-	-	-	-	-
MC521.2	3	3	-	-	-	-	-	-	1	1
MC521.3	-	-	-	3	-	-	-	-	1	-
MC521.4	-	3	-	-	-	-	-	-	-	-

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	**Understand**	**Apply**	**Analyze ✓**	**Evaluate**	**Create**

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Theory Component

Module No.	Topics	Ref.	Hrs.
1	Introduction to Soft Computing	**1,2**	4
	Soft computing Constituents, Characteristics of Neuro Computing and Soft Computing, Difference between Hard Computing and Soft Computing, Concepts of Learning and Adaptation.		
2	Neural Networks	**1,2**	12
	Basics of Artificial Neural Networks and Convolutional Neural Networks Short History of Neural Networks, Rosenblatt's Neuron Types of Learning (Supervised, Unsupervised, Reinforcement), Activation Functions Basic Models of Artificial Neural Network, Basic terminologies and architecture of ANN Supervised Learning, Linear Separability, Back-Propagation Network Basic architecture of CNN		
3	Fuzzy Set theory	**1,2**	12
	Fuzzy Controllers Crisp Logic, Fuzzy logic Classical Sets (Crisp Sets),Fuzzy Sets Classical Relations and Fuzzy Relations, Introduction, Cartesian Product of Relation, Classical Relation, Fuzzy Relations Fuzzification, De-fuzzification		
4	Fuzzy Decision Making:	**1.2**	10
	Introduction, Individual Decision Making, Multiperson Decision Making, Multiobjective Decision Making, Multiattribute Decision Making, Fuzzy Bayesian Decision Making, Fuzzy Logic Control Systems- Introduction, Control System Design, Architecture and Operation of FLC System, FLC System Models, Application of FLC Systems		
5	Genetic Algorithms	**1.2**	**4**
	The Cell, Chromosomes, Genetics, Reproduction, Selection, Traditional Optimization and Search Techniques Simple GA, Operators in GA, Encoding, Selection, Crossover, Mutation, Stopping Condition for GA .Applications of GA.		
6	**Self-Study Topics**		
	Application of Soft computing, Recurrent Neural Networks, Deep Learning: Deep Belief Network, Deep Reinforcement Learning		
		Total	42

Laboratory Component

Sr. No	Title of the Experiment
1	To design MP neuron for various problems
2	To design Perceptron Neural network
3	To design supervised NN model using BPN
4	Implement Union, Intersection, Complement and Difference operations on fuzzy sets.
5	To perform Union, Intersection and Complement operations To implement De-Morgan's Law.
6	To implement an unsupervised learning algorithm (KSOFM) for pattern classification problems.
7	To implement an unsupervised learning algorithm (LVQ) for pattern classification problems.
8	To design fuzzy controller
9	Implementation of Simple Genetic Application
10	Color recipe prediction using ANFIS

Text Books:

1. Introduction to Artificial Neural Systems Jacek M. Zurada Jaico Publishing House 1992
2. Fuzzy Logic with Engineering Applications Third Edition Timothy J. Ross Wiley India 1995
3. Principles of Soft Computing Second Edition S. N. Sivanandam and S. N. Deepa Wiley, India 2011
4. Deep Learning (Adaptive Computation and Machine Learning) First Edition I. Goodfellow, Y. Bengio, A. Courville, F. Bach O' Reilly 2016
5. Neural Networks, Fuzzy Logic and Genetic Algorithms Kindle edition S.Rajasekaran and G.A.Vijayalaks PHI Learning 2013

Reference Books:

1. Neuro-Fuzzy and Soft Computing– A Computational Approach to Learning and Machine Intelligence First Edition Jang J.S.R, Sun C. T. and Mizutani E. PHI 1997
2. Fundamentals of Neural Networks – Architectures, Algorithms, And Applications First Edition Laurene Fausett Pearson Education 2004
3. Fuzzy Set Theory and its Applications Second Edition H.J. Zimmermann Allied Publishers Ltd. 1996
4. An Introduction to Genetic Algorithms Fifth Edition Melanie Mitchell The MIT Press 1999
5. Neural Network Design Second Edition Hagan, Demuth, Beale CENGAGE Learning, India Edition 1996

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	SE	TE	L	T	P	Total
PE	BlockChain Technology	3	0	2	4	9	3	-	1	4
MC522		Examination Scheme								
		Component	ISE		MSE		ESE			Total
		Theory	75		75		150			300
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	
Course Objective: To give insights to students about blockchain and its various technologies to gain knowledge	
Course Outcomes (CO): ***At the End of the course students will be able to***	
MC522.1	Explain the basics of Block chain
MC522.2	Analyze various block chain Technology
MC522.3	Demonstrate the working of Bitcoin and Ethereum
MC522.4	Explain the basic of Multichain technology
MC522.5	Explain the use of IoT in block chain

CO-PO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
MC522.1	3	-	-	-	-	-	-	-	1	-
MC522.2	-	2	-	1	-	-	-	-	1	-
MC522.3	-	-	2	-	3	-	1	-	1	-
MC522.4	2	1	-	-	-	-	-	-	1	-
MC522. 5	3	-	-	-	-	-	1	-	1	-

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	**Understand**	**Apply**	**Analyze ✓**	**Evaluate**	**Create**

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Theory Component			
Module No.	**Topics**	**Ref.**	**Hrs**
1	**Introduction** Blockchain Basic , Four Core building blocks of blockchain, , Life cycle of Blockchain, Blockchain working, Difference between blockchain and databases, Centralized, De-Centralized and Distributed system, Distributed Ledger Technology, Blockchain ecosystem and structure, Features of Blockchain, Advantages of Blockchain.	**1,2**	**7**
2	**Blockchain Technology** Generation and evolution of Blockchain, Blockchain Solutions beyond Finance, Types of Blockchain Technology, Difference between public blockchain and private blockchain, Blockchain characteristics comparison, Blockchain requirement flowchart, Consensus Algorithm: introduction and objectives, Types of Consensus Algorithm: Proof of Work and Proof of Stake, Comparison between POW and POS, Blockchain Wallets introduction	**1,2**	**9**
3	**Bitcoin and Ethereum** History of Cryptocurrency, Cryptography in blockchain, Hash Functions, SHA hash Function, Merkle Tree, Digital Signatures, How does bitcoin transaction works, Bitcoin improvement Proposal (BIP) introduction, Types of BIP, BIP Lifecycle, Introduction to ethereum, Ethereum Technology Stack, Advantages and Drawbacks of ethereum, Smart Contract, ether, solidity.	**1,2**	**10**
4	**Introduction to Multichain** Multichain helping enterprise in blockchain, Multichain development timeline, Bitcoin to private blockchain, Aim of Multichain, The Handshaking Process, Use Cases of Multichain, Multichain permissions, Multichain assets, Multichain streams, Mining in multichain Technology and its flexibility, Security, speed and scalability in Multichain.	**1,2**	**9**
5	**IoT in Blockchain** Introduction to IoT, IoT Schematic Diagram, Challenges in IoT devices, Benefits of using Blockchain with IoT, Use Cases of blockchain IoT connected devices(Automotive industry ,Smart Vehicle monitoring system)	**1,2**	**7**
6	**Self-Study Topics**		

	Use Cases Of Blockchain Technology: ● Blockchain in Supply Chain ● Blockchain in Manufacturing ● Blockchain in Automobiles		

Laboratory Component

Sr. No	Title of the Experiment
1	Demonstrating secret key cryptography techniques
2	Demonstrating public key cryptography techniques
3	Demonstrating Hashing Techniques (SHA and MD5)
4	Demonstrate the working of the Merkle tree.
5	Implementing basic program using solidity
6	Implementing calculator using solidity
7	Implementing and demonstrating smart contract
8	Demonstrating Tokens in ethereum
9	Working with Web3.js in ethereum
10	Case study on bitcoin

Text Books :

[1] Tiana Laurence,"*Blockchain For Dummies*",First Edition,John Wiley & Sons, Inc,2017.
[2] Mark Gates,"*Blockchain :Ultimate guide to understanding blockchain, bitcoin, cryptocurrencies smart contracts and the future of money*", First Edition,Wise Fox Publishing and Mark Gates ,2017.

Reference Books :

[3] Joseph J. Bambara Paul R. Allen,"*Blockchain: A Practical Guide to Developing Business, Law, and Technology Solutions*", McGraw-Hill Education,2018.
[4] Ritesh Modi,"*Solidity Programming*",Packt Publishing,2018.
[5] Mayukh Mokhopadhyay,"*Ethereum Smart Contract Development*", Packt Publishing,2018

Web References

[6] https://ethereum.org/en/
[7] https://web3js.readthedocs.io/en/v1.2.9/
[8] https://studio.ethereum.org/

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	SE	TE	L	T	P	Total
PE	Data Warehousing and Mining	3	0	2	4	9	2	0	1	4
		Examination Scheme								
		Component	ISE		MSE		ESE			Total
MC523		Theory	75		75		150			300
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	MC502,Database Management System
Course Objective: To learn fundamentals of Data warehousing and mining	
Course Outcomes (CO): ***At the End of the course students will be able to***	
MC523.1	Demonstrate data warehouse principles and its working.
MC523.2	Construct the data needed for algorithms with the help of Data preprocessing techniques.
MC523.3	Make use of different association rules to solve real world problems.
MC523.4	Apply appropriate data mining methods like classification, clustering or association mining to the given problem.

CO-PO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
MC523.1	3	3	-	-	-	-	-	-	2	-
MC523.2	3	3	-	3	-	-	-	-	2	-
MC523.3	3	3	-	3	-	-	-	-	2	-
MC523.4	3	3	-	3	-	-	-	-	2	-

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	**Understand**	**Apply ✓**	**Analyze**	**Evaluate**	**Create**

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Theory Component

Module No.	Topics	Ref.	Hrs.
1	**Basic Concepts of Data Warehousing** Introduction to Data WareHouse, Differences between operational database systems and data WareHouse, Data WareHouse characteristics, Data WareHouse Architecture and its components, Extraction-Transformation-Loading, Logical (Multi-Dimensional), Data Modeling	3, 4	8
2	**Data Warehouse and OLAP Technology** Schema Design, star and snow-Flake Schema, Fact Constellation, Fact Table, Fully Addictive, Semi-Addictive, Non-Additive Measures, Dimension Table characteristics; Factless-Facts, Dimension Table characteristics, OLAP cube, OLAP Operations, OLAP Server Architecture-ROLAP, MOLAP and HOLAP	1, 2	8
3	**Introduction to Data Mining** Data Mining, Definition, KDD, Challenges, Data Mining Tasks Data Preprocessing- Data Cleaning, Missing Data Dimensionality Reduction, Feature Subset Selection, Discretization and Binarization, Data Transformation; Measures of similarity and dissimilarity-Basics	1,2	8
4	**Association Rules** Problem Definition, Frequent Item Set Generation, The APRIORI Principle, Support and Confidence Measures, Association Rule Generation, APRIORI Algorithm, The Partition Algorithms, FP-Growth Algorithms, Compact Representation of Frequent Item Set-Maximal Frequent ItemSet, Closed Frequent Item Set	2,4	6
5	**Classification** Problem definition, General Approaches to solving a classification problem, Evaluation of Classifiers, Classification techniques, Decision trees-Decision Tree Construction, Methods for expressing attribute test conditions, Algorithm for Decision tree Induction, Naïve-Bayes Classifier, K-nearest neighbor classification-Algorithm and characteristics	2,4	6
6	**Clustering** Problem Definition, Clustering overview, Evaluation of clustering algorithms, Partitioning clustering K-Means Algorithm, K-Means Additional Issues, PAM Algorithm, Hierarchical Clustering-Algorithm-Agglomerative Methods and Divisive Methods, Key Issues in Hierarchical Clustering, Outlier Detection	2,4	6
7	**Self-Study Topics**		

	Data Warehouse: virtual warehouse Data mining for Applications like Fraud Detection, Clickstream Mining, Market Segmentation, retail industry, telecommunications industry, banking & finance CRM etc.		
		Total	**42**

Laboratory Component

Sr. No	Title of the Experiment
1	Demonstrate OLAP operations
2	Working of Dimensional Modeling Tool
3	To implement various schema , Snowflake Schema.
4	Installation and working of ETL
5	To identify, install and experiment Data Mining tools.
6	Implementation of Data pre-processing
7	To implement Association Mining Algorithm
8	Implementation and analysis of Classification algorithms
9	Implementation and analysis of Linear regression
10	Implementation and analysis of clustering algorithms

Text Books :

[1] Han, Jiawei, Jian Pei, and Micheline Kamber," *Data mining: concepts and Techniques*", Third Edition, Elsevier, Morgan Kaufmann, 2011
[2] Ning Tan, Vipin Kumar, Michael Steinbanch *"Introduction to Data Mining"*, Pang Pearson Education.

Reference Books:

[3] Paulraj Ponnaiah "Data Warehousing Fundamentals" Student Edition Wiley.
[4] Arun K Pujari "Data Mining Techniques" Universities Press Second Edition 2015.

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	SE	TE	L	T	P	Total
PE	Ethical Hacking	3	0	2	4	9	3	0	1	4
		Examination Scheme								
		Component	ISE		MSE		ESE			Total
MC524		Theory	75		75		150			300
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	Computer Networks
Course Objective: To give students the knowledge about ethical hacking,its techniques and the countermeasures to prevent themselves from any kind of attacks.	
Course Outcomes (CO): ***At the End of the course students will be able to***	
MC524.1	Explain the basics of ethical hacking.
MC524.2	Analyze various types of attacks in ethical hacking.
MC524.3	Explain hijacking techniques and its countermeasures.
MC524.4	Analyze network and Web attacks and its countermeasures
MC524.5	Explain mobile and wireless attacks and its countermeasures.

CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
MC524.1	1	-	-	-	-	-	1	1	1	-
MC524.2	1	2	-	3	-	-	1	1	1	-
MC524.3	-	2	-	3	-	-	1	1	1	-
MC524.4	-	2	-	3	-	-	1	1	1	-

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create

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Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	**Title**	**Introduction to Ethical Hacking**	1,3	**8**
	1.1	Basics of Ethical Hacking		
	1.2	White, Grey, Black hat hackers		
	1.3	Various types of footprinting, footprinting tools, and countermeasures		
	1.4	Network scanning techniques and scanning countermeasures		
	1.5	Enumeration		
	1.6	System Hacking		
2	**Title**	**Various types of attacks**	1,3	**9**
	2.1	Malware Threats		
	2.2	Packet sniffing techniques and how to defend against sniffing		
	2.3	Social Engineering techniques and social engineering countermeasures		
	2.4	Identify theft		
	2.5	DoS/DDoS attack techniques, , DDoS attack tools, and DoS/DDoS countermeasures		
	2.6	Botnets		
3	**Title**	**Hijacking Techniques**	1,3	**8**
	3.1	Session Hijacking introduction		
	3.2	Session hijacking techniques and countermeasures		
	3.3	Different types of web server attacks		
	3.4	Web server attack methodology		
	3.5	Web server countermeasures		
4	**Title**	**Network and Web attack**	1,3	**8**
	4.1	Working of viruses		
	4.2	Virus analysis		
	4.3	Malware analysis procedure		
	4.4	Computer worms		
	4.5	Countermeasures		
	4.6	SQL Injection attacks and detection tools		
	4.7	Firewall : Introduction and Configuration		
5	**Title**	**Mobile and Wireless attacks**	1,3	**9**
	5.1	Hacking Mobile Platforms		
	5.2	Wireless Encryption		
	5.3	Wireless hacking methodology		
	5.4	IDS and honeypot evasion techniques		

	5.5	Evasion tools		
	5.6	Countermeasures		
6	**Self Study**	3.6 Hacking Web Applications 4.9 Wireless hacking tools 4.10 Wi-Fi security tools Various cloud computing concepts, threats, attacks, and security techniques and tools Cryptography attacks and cryptanalysis tools		
			Total	**42**

Laboratory Component

Sr. No	Title of the Experiment
1	Demonstrating Network Scanning Tools (nmap, netstat, nessus)
2	Demonstrating Enumeration tools (Metasploit, Hydra)
3	Demonstrating Packet sniffing tools (wireshark, tcpdump)
4	Demonstrating Social Engineering Toolkit
5	Demonstrating DOS and DDOS tools
6	Demonstrating SQL injection tools
7	Demonstrating Web Application Hacking (XSS and CSRF)
8	Demonstrating Mobile Hacking techniques
9	Demonstrating wireless Hacking Techniques
10	Demonstrating snort and firewall configuration

Text Books

1) Engebretson, P. (2011). *The Basics of Hacking and Penetration Testing* (First Edition). Syngress Press.
2) Stuttard, D., & Pinto, M. (2011). *The Web Application Hacker's Handbook: Finding and Exploiting Security Flaws* (Second Edition). Wiley Publication.
3) Erickson, J. (2008). *Hacking: The Art of Exploitation* (Second Edition). No Starch Press, Inc.
4) Baloch, R. (2015). *Ethical Hacking and Penetration Testing Guide* (First Edition). CRC Press.

Web References:

1. https://www.kali.org/
2. https://www.social-engineer.org/framework/se-tools/computer-based/social-engineer-toolkit-set/
3. https://owasp.org/
4. https://portswigger.net/research

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	SE	TE	L	T	P	Total
PE	Software Testing and Quality Assurance	3	-	2	4	9	3	-	1	4
		Examination Scheme								
		Component	ISE		MSE		ESE			Total
MC525		Theory	75		75		150			300
		Laboratory	50		--		50			100

Pre-requisite Course Codes, if any.	MC503,Software Engineering
Course Objective: To learn fundamentals of Software Testing and Quality Assurance.	
Course Outcomes (CO): ***At the End of the course students will be able to***	
MC525.1	Demonstrate the Software Testing Life Cycle and Testing types.
MC525.2	Apply Static and Dynamic Testing techniques to find bugs in the Software.
MC525.3	Make use of Test management to improve Test strategy.
MC525.4	Apply different Measurements and Metrics for Software Project Quality

CO-PO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2
MC525.1	-	3	-	-	-	-	-	-	-	1
MC525.2	3	3	-	-	-	-	-	-	-	1
MC525.3	-	3	-	-	-	-	-	-	-	1
MC525.4	3	3	-	-	-	-	-	-	-	1

BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	**Understand**	**Apply✓**	**Analyze**	**Evaluate**	**Create**

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Theory Component

Module No.	Topics	Ref.	Hrs.
1	**Introduction to Software Testing and Methodology** Evolution of Software Testing, Goals of Software Testing, Software Testing Definitions, Effective Software Testing vs. Exhaustive Software Testing , Principles of Testing. Software Testing Life Cycle (STLC), Software Testing Methodology, Verification and Validation (V&V),Verification of Requirements, High-level Design ,Low-level Design, Generic types of Testing-Functional, Non Functional	1,4	5
2	**Dynamic Testing** Black Box Testing- Equivalence Class Partitioning, State Transition Test ,Cause Effect Graphing, Boundary Value Analysis, Decision Table Technique. Need of White-Box Testing ,Logic Coverage Criteria, Basis Path Testing, Graph Matrices, LoopTesting, Data Flow Testing, Mutation Testing.	2,4	8
3	**Static Testing and TestLevels** Structured Group Examinations – Reviews, types of reviews, General process, Roles and responsibilities, Selection criteria. The compiler as a static analysis tool. Unit Testing , Integration Testing , System Testing, Test Point Analysis ,Acceptance Testing, Performance Testing, Regression Testing, Ad-hoc testing, Alpha, Beta Tests	2,4	7
4	**Test Management** Test organization, Test Planning, Test plan hierarchy Detailed test design and test specifications. Incident Management – Test Log, Incident Reporting, Classification, Status.	1,4	6
5	**Agile Testing** Agile Testing Life Cycle, Agile Testing Quadrants, Agile Testing Techniques: Behavior Driven Development, Session Based testing, Acceptance Driven testing, Exploratory Testing	3	5
6	**Software Quality** Definitions of Quality, Quality Attributes, Quality Assurance vs Quality ControlContents of SQA Plan, Software Quality Assurance: - Organizational Initiatives, Need for SQA function benefits	2,5	4
7	**Metrics and Measurement**	2,5	7

	Understanding Measurement and Metrics, Metrics for Tracking System Test, Metrics for Defect Management, Metrics for Software Maintenance, Metrics for Requirement ,Requirement Traceability Matrix and its types.		
		Total	**42**

Laboratory Component

Sr. No	Title of the Experiment
1	Write and test a program using Black box Testing methods
2	White box Testing methods using Manual and Automation Testing
3	Study of automation tool, run test cases and use Base URL to run test cases in different domains
4	Using TestNg Framework
5	Apply Bug Tracking process using tool
6	Mobile Apps Testing,Run test cases on mobile devices and emulators.
7	Test Management tool
8	Study of Behaviour Driven development
9	Apply Requirement Stability Index and Traceability Matrix for given case study
10	Develop Pareto Charts for a given Case study

Textbooks

[1] Kshirasagar Naik Priyadarshini Tripathy ``Software Testing and Quality Assurance: Theory and Practice", WILEY,2017.
[2] Nina S. Godbole" Software Quality Assurance", Alpha Science International Ltd.,2ndEdition,June 2017.
[3] Lisa Crispin,Janet Gregory, "Agile Testing: a brief Introduction", Library and Archives Canada ,3rd edition 2019.

References

[4] M.G.Limaye" Software Testing Principles, Techniques and Tools", Tata McGraw Hill,July2017.
[5] Solis Tech, "Quality Assurance: Software Quality Assurance Made Easy", Createspace

Independent Publishing Platform, January 2016.
[6]Naresh Chauhan, "Software Testing: Principles and Practices", Oxford University Press,1stEdition, 2010.