MSPM'S
Deogiri Institute of Engineering and Management Studies,
Chhatrapati Sambhajinagar
(An Autonomous Institute)
Department of Computer Science and Engineering

B.TECH. (COMPUTER SCIENCE AND ENGINEERING) PROGRAM STRUCTURE (2025-29)

Semester		I	II	III	IV	V	VI	VII	VIII	Total Credits
Basic Science Course	BSC/ESC	08	07		--	--	--	--	--	15
Engineering Science Course		08	07		--	--	--	--	--	15
Programme Core Course (PCC)	Program Courses	--	02	10	10	10	10	12	--	54
Programme Elective Course (PEC)		--	--	--	--	04	06	04	06	20
Vocational Courses **(Industrial collaboration Course)**	Skill Courses	--	--	--	--	--	--	02	--	10
Skill Enhancement Course **(Professional Development)**		01	01	01	01	02	02	--	--	
Ability Enhancement Course (AEC - 01, AEC-02) **(Ex. Language Lab, CS, EEE)**	Humanities Social Science and Management (HSSM)	02	--	--	02	--	--	--	--	04
Entrepreneurship/Economics/ Management Courses		--		02	02	--	--	--	--	04
Indian Knowledge System (IKS)			02		--	--	--	--	--	02
Value Education Course (VEC) (Ex. UHV-II, environmental courses)		--	--	02	02	--	--	--	--	04
Constitution of India					AU					AU
Do It Yourself (DIY)	Experiential Learning Courses	AU	AU	01	01	01	01	01	--	05
PBL		01	01	01	01	01	01	01	--	07
Internship/ OJT		--	---			--	--	--	12	12
Co-curricular Courses (CC) (NSS / YOGA/ Health & Wellness)	Liberal Learning Courses	01	01	--	--	--	--	--	--	02
Open Elective (OE) Other than a particular program		--	--	04	02	02	--	--	--	08
Total Credits (Major)		**21**	**21**	**21**	**21**	**20**	**20**	**20**	**18**	**162**
Multidisciplinary Minor (MDM)	Multi-disciplinary Courses		-	02	02	04	02	04	--	**14**
• **(B.E./ B.Tech. or Equivalent) in Engg./ Tech. with Multidisciplinary Minor** • **Major + MDM = 162+14 = 176 Credits**										**176**
Honors and Multidisciplinary Minor		-	-	2	4	4	4	4	-	**18**

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• **4-Years Bachelor's degree (B.E./ B.Tech. or Equivalent) in Engg./ Tech.- Honors and Multidisciplinary Minor** • **Major + Honors + MDM = 162+18+14 = 194 Credits** • Students with minimum **CGPA of 7.5** without backlog courses at the end of **Second semester** and should have earned **42 credits** are eligible for admission to the UG Bachelor's Degree with Honors.											**194**
Honors with Research and Multidisciplinary Minor								08	10		**18**
• **4-Years Bachelor's degree (B.E./ B.Tech. or Equivalent) in Engg. / Tech.- Honors with Research and Multidisciplinary Minor** • **Major + Research + MDM = 162+18+14 = 194 Credits** • Students with minimum **CGPA of 7.5** without backlog courses at the end of **Sixth semester** and should have earned **124 credits** are eligible for admission to the UG Bachelor's Degree with Research.											**194**
Double Minors (Multidisciplinary and Specialization Minors)				2	4	4	4	4			**18**
• **4-Years Bachelor's degree (B.E./ B.Tech. or Equivalent) in Engg. / Tech.- Major Engg. Discipline with Double Minors (Multidisciplinary and Specialization Minors)** • **Major + MDM + Specialized Minor= 162+14+18 = 194 Credits** • Students with minimum **CGPA of 7.5** without backlog courses at the end of **Second semester** and should have earned **42 credits** are eligible for admission to the UG Bachelor's Degree with Double Minor.											**194**

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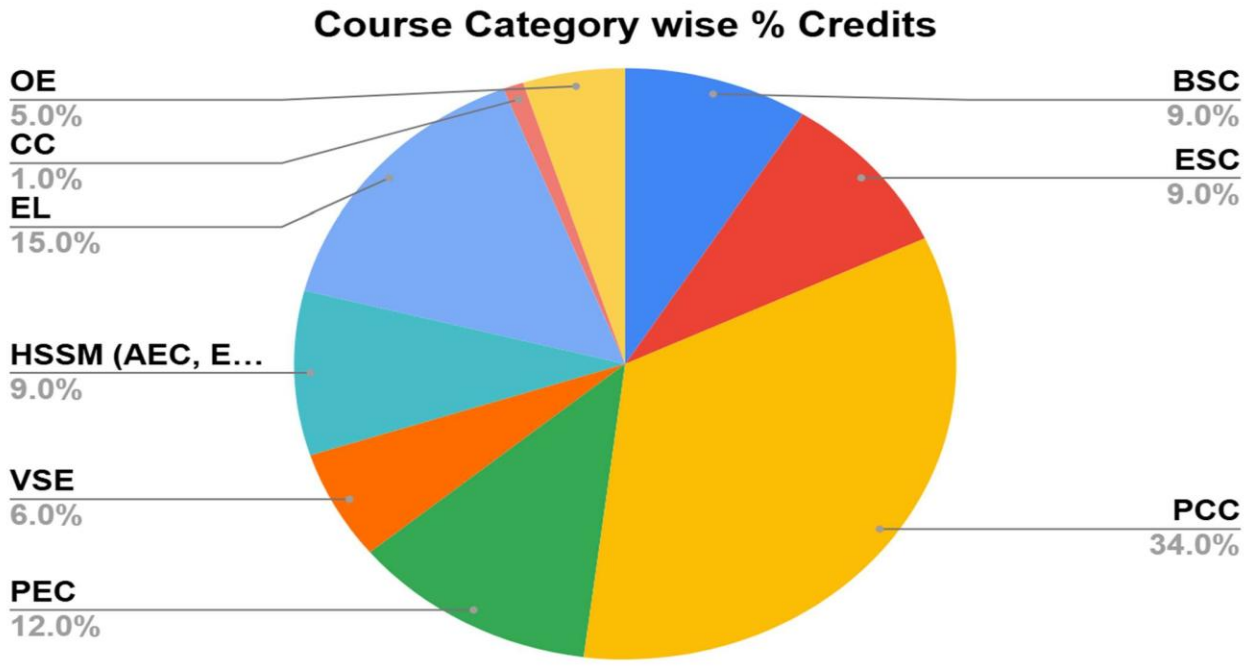
B.Tech. in Computer Science and Engineering		
Course Category	**Credits**	**% Credits**
Basic Science **(BSC)**	15	9%
Engineering Science **(ESC)**	15	9%
Program Core Courses **(PCC)**	54	34%
Program Elective Courses **(PEC)**	20	12%
Vocational & Skill Enhancement **(VSE)**	10	6%
Humanity, Social Science & Management (AEC, EM, IKS, VEC) **HSSM**	14	9%
Experiential Learning **(EL)**	24	15%
Co-Curriculum Courses **(CC)**	2	1%
Open Electives **(OE)**	8	5%
Total Credits	**162**	



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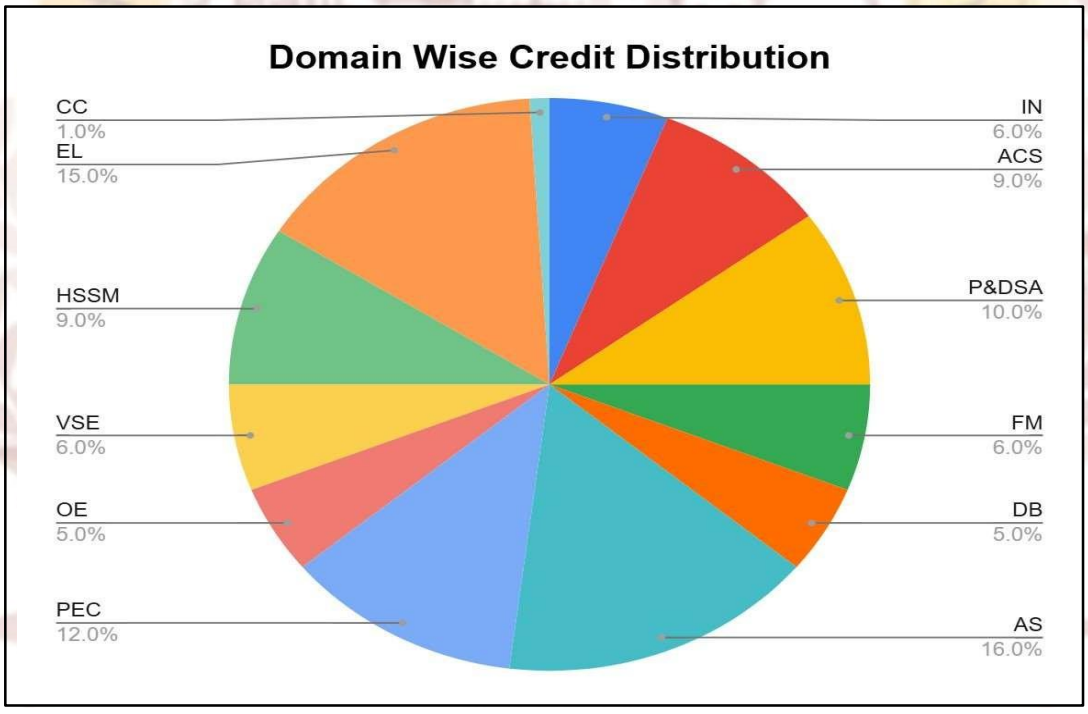
B.Tech. in Computer Science and Engineering		
Domain	**Credits**	**% Credits**
Infrastructure and Networking **(IN)**	10	6%
Allied CS Courses **(ACS)**	15	9%
Programming and DSA **(P&DSA)**	16	10%
Formal Methods **(FM)**	09	6%
Database **(DB)**	08	5%
Allied Science **(AS)**	26	16%
Program Elective Courses **(PEC)**	20	12%
Open Electives **(OE)**	08	5%
Vocational & Skill Enhancement **(VSE)**	10	6%
Humanity, Social Science & Management **(AEC, EM, IKS, VEC)** HSSM	14	9%
Experiential Learning **(EL)**	24	15%
Co-Curriculum Courses **(CC)**	02	1%
Total Credits	**162**	



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SEMESTER III													
Category	Course Code	BOS	Name of the Course	Teaching Scheme				Evaluation Scheme					Credits
				L	T	PR	Total	CA-I	CA-II	MSE	ESE	Total	
PCC	CS253201	CS	Discrete Mathematics and Statistics	3			3	10	10	20	60	100	3
PCC	CS253202	CS	Data Structures	3			3	10	10	20	60	100	3
PCC	CS253203	CS	Operating System	3			3	10	10	20	60	100	3
VEC	GE253703	CS	Universal Human Values-II	2			2	10	10	20	60	100	2
EEM	CS253704	CS	Financial Management	2			2	10	10	20	60	100	2
OE	CS25350_	CS	Open Elective-I*	4			4	10	10	20	60	100	4
PCC	CS253204L	CS	DS and OS Lab			2	2	15	15		20	50	1
EL	CS253805	CS	CL PBL			2	2	15	15		20	50	1
SEC	GE253603	CS	Professional Development -III			2	2	15	15		20	50	1
EL	CS253806	CS	Do It Yourself -III			2	2	15	15		20	50	1
Total for Major				**17**		**8**	**25**					**900**	**21**
MDM	CS253401	CS	MDM-1 *	2			2	10	10	20	60	100	2
Total for Major with Multidisciplinary Minor (Mandatory Credits)													**23**
HMM	CS253205	CS	HMM 1	2			2	10	10	20	60	100	2
OR (*Students will be allotted for either HMM or DM as per defined criteria)													
DM	CS253206-207	CS	DM 1	2			2	10	10	20	60	100	2
Total for Major with MDM + (HMM/DM)				**21**		**8**	**29**					**1100**	**25**

*Courses offered by the Computer Science and Engineering department for other department students.

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SEMESTER IV													
Category	Course Code	BOS	Name of the Course	Teaching Scheme				Evaluation Scheme					Credits
				L	T	PR	Total	CA-I	CA-II	MSE	ESE	Total	
PCC	CS254208	CS	Object Oriented Programming using JAVA	3			3	10	10	20	60	100	3
PCC	CS254209	CS	Computer Architecture and Organization	3			3	10	10	20	60	100	3
PCC	CS254210	CS	Database Management System	3			3	10	10	20	60	100	3
OE	CS25450_	CS	Open Elective-II*	2			2	10	10	20	60	100	2
AEC	CS254705	BSH	Modern Indian Language-II	2			2	10	10	20	60	100	2
EEM	CS254706	CS	Entrepreneurship Development	2			2	10	10	20	60	100	2
HSSM-VEC	CS254707	CS	Environmental and Sustainable Engineering	2			2	10	10	20	60	100	2
PCC	CS254211L	CS	OOPJ and DBMS Lab			2	2	15	15		20	50	1
EL	CS254807	CS	PBL-IV CL PBL			2	2	15	15		20	50	1
SEC	CS254604	CS	Professional Development -IV			2	2	15	15		20	50	1
EL	CS254808	CS	Do It Yourself -IV			2	2	15	15		20	50	1
Total for Major				**17**		**8**	**25**					**900**	**21**
MDM	CS254402	CS	MDM 2*	2			2	10	10	20	60	100	2
Total for Major with Multidisciplinary Minor (Mandatory Credit)													**23**
HMM	CS254212	CS	HMM 2	4			4	10	10	20	60	100	4
OR													
DM	CS254213-214	CS	DM 2	4			4	10	10	20	60	100	4
Total for Major with MDM + (HMM/DM)				**23**		**8**	**31**					**1100**	**27**

* Courses offered by Computer Science and Engineering Department for Other Departments Students.

Note: Multiple entry & exit criteria will be in accordance with the AICTE/UGC/DTE/NEP-2020 guidelines.

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Open Elective Bucket Offered by All Departments						
Department	OE I (SEM III)		OE II (SEM IV)		OE III (SEM V)	
	Credit: 4		Credit: 2		Credit: 2	
	Course code	Course Name	Course code	Course Name	Course code	Course Name
Mechanical	ME253501	Mechatronics	**ME254504**	**3D Printing Technologies**	**ME255507**	**3D Printing and Rapid Prototyping**
	ME253502	Project Management for Engineers	ME254505	Robotics and Automation	ME255508	EV Technology
	ME253503	Numerical Methods in Engineering	ME254506	Energy Storage and Management Systems	ME255509	Renewable Energy Sources
Civil	**CE253501**	Environmental Impact Assessment	**CE254504**	**Remote Sensing and Geographic Information Systems**	**CE256507**	Interior Designs and Drawing
	CE253502	Experimental Stress Analysis	CE254505	Town Planning	CE256508	Development Engineering
	CE253503	Composite Materials	CE254506	Operation Research	CE256509	Planning for Sustainable Development
E&TC	**ET253501**	**Digital Electronics**	**ET254504**	**Sensors and Actuators**	**ET255507**	**Internet of Things**
	ET253502	Signals & Systems	ET254505	Electrical Machines	ET255508	Instrumentation Engineering
	ET253503	Electronic Devices and Circuits	ET254506	Computer Architecture	ET255509	Wireless Communication Basics
CSE*	**CS253501**	**C Programming**	**CS254504**	**Object Oriented Programming using Java**	**CS255507**	**Advanced JAVA**
	CS253502	Data Science and Analytics	CS254505	Fundamentals of Machine Learning	CS255508	Artificial Intelligence and Applications
	CS253503	Open Source and Software Technology	CS254506	Web Development Technologies	CS255509	Computer Network and Security
AIML	**AI253501**	**Python Programming**	AI254504	Cyber Security Fundamentals	AI255507	**Internet of Things**
	AI253502	Prompt Engineering	AI254505	Artificial Intelligence &	AI255508	Autonomous Intelligent

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				Data Science		System
	AI253503	Components and Applications of the Internet of Things	AI254506	Ethical Hacking	AI255509	Quantum Computing

***The Open Elective (OE) courses offered by the Department of Computer Science and Engineering are exclusively intended for students of other departments and are not open to students of the Computer Science and Engineering Department.**

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Multidisciplinary Minor (MDM) Courses Offered by All Departments										
Department	MDM-I (SEM III)		MDM-II (SEM IV)		MDM- III (SEM V)		MDM- IV (SEM VI)		MDM-V (SEM VII)	
	Credit: 2		Credit: 2		Credit: 4		Credit: 2		Credit: 4	
	Course code	Course Name	Course code	Course Name	Course code	Course Name	Course code	Course Name	Course code	Course Name
Mechanical	ME253401	Basic Mechanical Engineering	ME254402	Metrology and Mechanical Measurements	ME255403	Product Design and Development	ME256404	Smart Materials	ME257405	Automobile Engineering
Civil	CE253401	Basic Civil Engineering	CE254402	Building Construction and Materials	CE255403	Building Planning & Drawing	CE254404	Building Estimates & Tendering	CE254405	Construction Management
E&TC	ET253401	Basic Electronics and Communication Engineering	ET254402	Digital Electronics and Logic Design	ET255403	Microprocessors and Microcontrollers	ET256404	Communication Systems and Networking	ET257405	Embedded Systems
CSE*	CS253401	Database Systems	CS254402	Computational Statistics for AI	CS255403	Predictive Analytics and Visualization	CS256404	Advanced Machine Learning	CS257405	Prompt Engineering
AIML	AI253401	Database Systems	AI254402	Computational Statistics for AI	AI255403	Predictive Analytics and Visualization	AI256404	Advanced Machine Learning	AI257405	Prompt Engineering

***The MDM courses offered by the Department of Computer Science and Engineering are exclusively intended for students of other departments and are not open to students of the Computer Science and Engineering Department.**

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***Honors**

Semester	Code	BOS	Minor	No. of Credits
SEM III	CS253205	CS	HMM I	2
SEM IV	CS254212	CS	HMM II	4

***Honors courses offered by the Department of Computer Science and Engineering are exclusively for Computer Science and Engineering students. Only students with a minimum CGPA of 7.5 and no backlogs at the end of the Second Semester are eligible for the Honors Track. Students must maintain a minimum CGPA of 7.5 and remain free of backlogs throughout the program to continue in the Honors Track.**

***Specialization Minor (Double Minor)**

Semester	No. Of Credits		Programing Track	Full Stack Development Track
SEM III	2	Course Code	CS253206	CS253207
		BOS	CS	CS
		Course	DM I	DM I
SEM IV	4	Course Code	CS254213	CS254214
		BOS	CS	CS
		Course	DM II	DM II

***The Specialization Minor (Double Minor) offered by the Department of Computer Science and Engineering is exclusively for Computer Science and Engineering students. Only students with a minimum CGPA of 7.5 and no backlogs at the end of the Second Semester are eligible. Students must maintain a minimum CGPA of 7.5 and remain free of backlogs throughout the program. To earn the Specialization Minor (Double Minor), students must complete one specialization track in a Computer Science and Engineering domain offered by the Department.**

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Course Title: Discrete Mathematics and Statistics **Course Code: CS253201**	**Course Category: PCC**	
Teaching Scheme	**Examination Scheme**	
Lectures: 03 hrs. / week	CA-1	10 Marks
Tutorial: –	CA-2	10 Marks
Credits: 03	MSE	20 Marks
Semester: Second Year (Semester III)	ESE	60 Marks

Course Prerequisite:

- **Basic Mathematics** – Arithmetic operations, fractions, percentages, ratios, algebraic manipulation.
- **Basic Statistics** – Mean, median, mode, probability basics.

Course Description: This course introduces core concepts of discrete mathematics and statistics designed for Computer Science, AI/ML, and Data Science applications. It develops logical reasoning through propositional logic, predicates, and inference techniques used in algorithms and intelligent systems. The course covers sets, functions, relations, graphs, and trees, forming the foundation for data structures, networks, and machine learning models. It also introduces statistical methods, probability, and distributions essential for data analysis and predictive modeling. Further, it focuses on inferential statistics and hypothesis testing for data-driven decision-making and model evaluation.

Course Objectives:

1. **To develop** logical reasoning skills using propositional logic, predicates, and rules of inference for solving computational problems.
2. **To understand** fundamental concepts of sets, functions, relations, graphs, and trees for their applications in computer science and data structures.
3. **To introduce** statistical methods and probability theory for analyzing data and understanding uncertainty in real-world scenarios.
4. **To apply** inferential statistical techniques, including hypothesis testing, for data-driven decision making and evaluation of models in AI/ML and data science.

Course Outcomes:		
COs	**After completion of the course students will be able to**	**Bloom's Level**
CO1	**Recall** fundamental concepts of propositional logic, set theory, graph theory, statistics, probability, and hypothesis testing.	Remember (Level 1)
CO2	**Explain** principles of logical reasoning, set operations, functions, graph structures, statistical measures, probability distributions, and hypothesis testing procedures.	Understand (Level 2)
CO3	**Demonstrate** logical rules, set operations, graph algorithms, statistical measures, and probability concepts to solve computational and data analysis problems.	Apply (Level 3)
CO4	**Examine** complex problems using logical inference, graph-based models, statistical methods, and hypothesis testing techniques for data-driven decision making.	Analyze (Level 4)

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CO-PO-PSO Mapping													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	1	–	–	–	–	–	–	–	–	2	1	1
CO2	3	2	1	1	–	–	–	–	–	–	2	2	1
CO3	3	3	2	2	2	–	–	–	–	1	2	3	2
CO4	3	3	2	3	2	1	–	–	–	1	3	3	2

Assessment	
CA-1 (a)	Subjective Test / Assignment/ MCQ Test etc.
CA-2 (b)	Subjective Test / Assignment/ MCQ Test etc.
MSE (c)	Subjective Test

Course Contents		
Unit 1	**Introduction to Propositional Logic** Propositions, truth values, truth tables for operators, truth tables of compound propositions, precedence of logical operators. Propositional equivalences: logical equivalences, constructing new logical equivalences, normal forms. Predicates and quantifiers, universal and existential, nested quantifiers, order of quantifiers, negating nested quantifiers. Rules of inference: valid arguments in propositional logic, Rules of inference for propositional logic, using rules of inference to build arguments, resolution, fallacies.	6 Hrs.
Unit 2	**Basic Discrete Structures** Sets: Venn diagrams, subsets, size of a set, power sets, cartesian products, set operations, Function: subjective, injective, bijective and inverse functions, composition of function, relation and its properties, equivalence and partial order relations, Pigeonhole principle, permutation and combination	6 Hrs.
Unit 3	**Graph and Trees** Basic terminology, multi graphs and weighted graphs, Paths and circuits, shortest path problems, Euler and Hamiltonian paths, representation of graphs, isomorphic graphs, planar graphs, connectivity, matching coloring. Trees: Rooted trees, Path length in rooted tree, Binary search trees, spanning trees and cut set, Minimal spanning trees, Kruskal's and Prim's algorithms for minimal spanning tree.	6 Hrs.
Unit 4	**Introduction to Statistics** What is statistics, population vs sample, Types of statistical data- categorical, numerical (Continuous), ordinal, interval, ratio, univariate and bivariate analysis, measures of central tendency: mean, median, mode, harmonic mean, measures of dispersion - variance, standard deviation and coefficient of variation, outliers, data visualization- line graph, scatter, box plots, histogram.	6 Hrs.

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Unit 5	**Probability and Distributions** Basics of probability- random experiments, sample space, events, axioms of probability, addition and multiplication laws of probability, conditional probability and independence, Bayes' theorem, discrete vs continuous random variables, Introduction to inferential statistics, what is distribution, concept of probability distributions, expectation(mean) and variance, skewness and interpretations, kurtosis.	6 Hrs.
Unit 6	**Hypothesis Testing and Statistical Tests** Typical analysis procedures, introduction to inferential statistics, point estimation, confidence intervals, hypothesis testing concept, null and alternative hypotheses, Type I and Type II errors, rejection region, level of significance, p-value, one-tailed and two-tailed tests, tests on numerical data– distribution of sample mean, comparison of two groups– Z-test. Real-world case study on hypothesis testing in data-driven decision making.	6 Hrs.

Sr. No.	Textbooks
1.	S. C. Gupta, Fundamentals of Statistics, Himalaya Publishing House, 7th Revied and Enlarged Edition, 2016.
2.	C. L. Liu, Elements of Discrete Mathematics, McGraw-Hill Publication, 3 rd Edition, 2008.
Sr. No.	**Reference Books**
1.	Kishor S. Trivedi, Probability, Statistics with Reliability, Queuing and Computer Science Applications, Wiley India Pvt. Ltd, 2nd Edition, 2001.
2.	Murray Spiegel, John Schiller, R. ALU Srinivasan, Probability and Statistics, Schaum's Outlines, 4th Edition, 2013.
3.	Kenneth H. Rosen, Discrete Mathematics and its Applications, McGraw-Hill Publication, 6 th Edition, 2010
4.	Lipschutz, Discrete Mathematics, McGraw-Hill Publication, 3 rd Edition, 2009
Sr. No.	**Web Resources**
1.	NPTEL - Discrete Mathematics (IIT Ropar) https://onlinecourses.nptel.ac.in/noc26_cs68/
2.	NPTEL - Introduction to Probability and Statistics (IIT Madras) https://onlinecourses.nptel.ac.in/noc26_mg59/
3.	Udemy - Discrete Mathematics 1 https://www.udemy.com/courses/search/?q=discrete+mathematics&src=sac&kw=discrete+Mathema
4.	Coursera -Probability & Statistics for Machine Learning & Data Science https://www.coursera.org/learn/machine-learning-probability-and-statistics

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Course Title: Data Structures **Course Code: CS253202**	**Course Category: PCC**	
Teaching Scheme	**Examination Scheme**	
Lectures: 03 hrs. / week	CA-1	10 Marks
Tutorial: -	CA-2	10 Marks
Credits: 03	MSE	20 Marks
Semester: Second Year (Semester III)	ESE	60 Marks

Course Prerequisite:

- **Programming Languages fundamentals**: Familiarity with data types, variables, operators, Input/output statements, conditional and control statements, Pointers, Arrays, Strings
- **Problem-Solving Skills**: Logical thinking and algorithmic approach to solving problems, Ability to write simple algorithms or flowcharts.

Course Description: This course introduces fundamental data structures and their applications in efficient problem solving. Students learn arrays, linked lists, stacks, queues, trees, and graphs, along with algorithm design, complexity analysis, and memory management. Emphasis is placed on implementation, performance tradeoffs, and real-world use cases to develop logical thinking and programming skills for scalable software development in modern computing environments today.

Course Objectives:

1. Explain fundamental concepts of data, data types, data structures, and Abstract Data Types (ADT), and analyze algorithms in terms of time and space complexity.
2. Solve computational problems by applying appropriate data structures such as arrays, hash tables, stacks, queues, and linked lists.
3. Implement tree and graph data structures, including binary trees, binary search trees, heaps, and adjacency matrix representations, and perform related operations and traversals.
4. Demonstrate proficiency in searching and sorting algorithms, including sequential, binary search, skip lists, insertion sort, selection sort, and radix sort.
5. Select and implement suitable data structures and algorithms to develop efficient, maintainable, scalable software solutions.

Course Outcomes:

COs	After completion of the course students will be able to	Bloom's Level
CO1	**Identify** fundamental concepts of data structures, abstract data types (ADTs), algorithm design principles and their classifications.	Remember (Level 1)
CO2	**Explain** the representation and types of linear and nonlinear data structures.	Understand (Level 2)
CO3	**Demonstrate** the operations of linear and non-linear data structures, including arrays, linked lists, stacks, queues, trees, and graphs.	Apply (Level 3)
CO4	**Examine** the efficiency of algorithms and data structures using time and space complexity	Analyze (Level 4)
CO5	**Implement** and **explore** data structure operations and algorithms (such as traversal, insertion, deletion, searching, and sorting) to solve real-world problems effectively.	Analyze (Level 4)
CO6	**Compare** and **assess** appropriate searching, sorting, and hashing techniques for problem solving.	Evaluate (Level 5)

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CO-PO-PSO Mapping													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	2	–	–	–	–	–	–	–	–	1	2	1
CO2	3	2	–	–	–	–	–	–	–	–	–	2	1
CO3	2	2	1	–	–	–	–	–	–	–	–	2	1
CO4	3	3	–	1	–	–	–	–	–	–	1	3	1
CO5	3	2	2	1	–	–	–	1	1	–	1	3	1
CO6	2	2	2	1	–	–	–	–	–	–	1	3	2

Assessment	
CA-1 (a)	Subjective Test / Assignment/ MCQ Test etc.
CA-2 (b)	Subjective Test / Assignment/ MCQ Test etc.
MSE (c)	Subjective Test

Course Contents		
Unit 1	**Introduction** Data, Data types, Data structure, Classification of Data Structures, Abstract Data Type (ADT), representation of Information in memory, Characteristics of algorithm, algorithm design basics, Program analysis and Performance measurement, Introduction to space and time complexity, Asymptotic Notations.	6 Hrs.
Unit 2	**Arrays and Hash Tables** Introduction, Array Operations, representation of Arrays in Memory, Implementation of One- & Two-Dimensional Arrays in Memory, Concept of sequential organization, Linear and non-linear data structures, Storage representation, Array processing, Sparse matrices, Transpose of sparse matrices, Hash table, Direct address tables, Hash tables, Hash functions, Open addressing, Perfect hashing.	6 Hrs.
Unit 3	**Linked list** Concept of linked organization, Singly and doubly linked list , Circular linked list, Operations such as insertion, deletion, concatenation, traversal of linked list, dynamic memory allocation concepts, garbage collection and memory management basics.	6 Hrs.
Unit 4	**Stacks and Queues** Introduction, stack and queue as ADT, Representation and implementation of stack and queue using Sequential and linked allocation, Circular queue and its implementation, Priority queue. Application of stack for expression evaluation and expression conversion, Recursion.	6 Hrs.

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Unit 5	**Trees and Graphs** Basic terminology, Binary trees and its representation, Insertion and deletion of nodes in binary tree, Binary search tree and its traversal, Threaded binary tree, Heap, Balanced Trees, Terminology and representation of graphs using adjacency matrix, Warshall's algorithm.	6 Hrs.
Unit 6	**Searching and Sorting** Sequential, Binary searching, Skip lists – dictionaries, Skip list representation, operations – insertion, deletion, searching, Insertion sort, Selection sort, Radix sort, Shell sort.	6 Hrs.

Sr. No.	Textbooks
1.	Weiss, Data structures and algorithms analysis in C++, Pearson Education, 4th Edition, 2013
2.	Horowitz and Sahani, Fundamentals of Data Structures, Universities Press, 2nd Edition, 2008
Sr. No.	**Reference Books**
1.	S. Lipschutz, Data Structures, McGraw-Hill Publication, Revised 1st Edition, 2014
2.	Y. Langsm, M. Augenstin, A. Tanenbaum, Data Structure using C and C++, Prentice Hall India Learning Private Limited,2nd edition, 1998
3.	Thomas Cormen, Introduction to Algorithms, PHI Publication, 2nd Edition, 2002
4.	Venkatesan& Rose, Data Structures, Wiley Publication, 1st Edition, 2015
5.	Goodrich &Tamassia, Data Structure & Algorithm in C++, Wiley Publication, 2nd Edition, 2011.
Sr. No.	**Web Resources**
1.	NPTEL course: Programming, data structures and algorithms using Python (IITM): https://onlinecourses-archive.nptel.ac.in/noc18_cs34/
2.	NPTEL course: Data Structures and Algorithms Design https://onlinecourses.nptel.ac.in/noc25_cs81/

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Course Title: Operating Systems **Course Code: CS253203**	**Course Category: PCC**	
Teaching Scheme	**Examination Scheme**	
Lectures: 03 hrs / week	CA-1	10 Marks
Tutorial: –	CA-2	10 Marks
Credits: 03	MSE	20 Marks
Semester: Second Year	ESE	60 Marks

Course Prerequisite: Basic understanding of programming (C or any high-level language),Fundamentals of Computer System,Concepts of data structures such as arrays, stacks, queues, and linked lists

Course Description: This course provides a comprehensive understanding of operating system concepts, design principles, and functionalities. It focuses on process management, scheduling, synchronization, memory management, file systems, and I/O management. The course enables students to understand how operating systems efficiently manage hardware and software resources.

Course Objectives:

1. To understand fundamental concepts and functions of operating systems
2. To study process management, scheduling, and synchronization mechanisms.
3. To analyze memory management and virtual memory techniques
4. To explore file systems and I/O management
5. To evaluate Operating System performance and resource management strategies

Course Outcomes:		
COs	**After completion of the course students will be able to:**	**Bloom's Level**
CO1	**Define** fundamental concepts of operating systems including processes, memory, file systems, and Input/output management.	Remember (Level 1)
CO2	**Explain** the structure, services, and working of operating system components such as scheduling, synchronization, memory, and file management.	Understand (Level 2)
CO3	**Implement** Operating system algorithms for process and resource management	Apply (Level 3)
CO4	**Utilize** process management, memory management and virtual memory techniques for efficient resource utilization in operating systems.	Apply (Level 3)
CO5	**Compare** the performance of operating system techniques including scheduling, synchronization, memory, and disk management.	Analyze (Level 4)
CO6	**Select** appropriate operating system strategies for efficient system and resource management.	Evaluate (Level 5)

CO-PO-PSO Mapping													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	1	-	-	-	-	-	-	-	-	-	2	2
CO2	3	2	–	–	1	–	–	–	1	–	1	2	3
CO3	3	3	2	1	2	–	–	–	–	–	1	3	2
CO4	3	2	2	1	2	–	–	–	–	–	1	3	2
CO5	3	3	2	2	2	1	–	–	1	–	2	3	2
CO6	3	3	3	2	2	1	1	–	1	–	2	3	3

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Assessment	
CA-1 (a)	Subjective Test / Assignment/ MCQ Test etc.
CA-2 (b)	Subjective Test / Assignment/ MCQ Test etc.
MSE (c)	Subjective Test

Course Contents		
Unit 1	**Introduction to Operating System** Operating System definition and functions, User view, System view, Operating System structures(Layered, Micro Kernel,Modular), Operating System services, System Calls, Types of system calls, Types of OS: Batch, Multiprogramming, Time sharing, Parallel, Distributed & Real-time, System Design and Implementation, System Generations.	6 Hrs.
Unit 2	**Process and CPU Scheduling** Process Concept, process State Transition, Process Scheduling, Operation on process, Inter-process Communication, Introduction to threads:Multi threading models, Scheduling Criteria, Types of Scheduling: Preemptive, Nonpreemptive, Long-term, Medium-term, Short-term. Scheduling Algorithms: First Come First Serve(FCFS), Shortest Job First(SJF), Shortest Remaining Job First(SRTF), Priority, Round Robin,etc.	6 Hrs.
Unit 3	**Process Synchronization and Deadlock** Synchronization: The critical-section problem, Critical regions, Peterson's Solution, Synchronization Hardware, Semaphores, Classical Problems of synchronization, and Monitors Deadlocks: Systems Model, Deadlock characterization, Methods for handling Deadlocks, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection, Recovery from Deadlock, Combined approach to deadlock Handling.	6 Hrs.
Unit 4	**Memory Management** Logical and Physical address, Memory Allocation, Memory Partitioning: Fixed Partitioning, Dynamic Partitioning,, Fragmentation and Compaction, Paging, Segmentation, Address translation, Placement Strategies: First Fit, Best Fit, Next Fit and Worst Fit.	6 Hrs.
Unit 5	**Virtual Memory** Concept of Virtual Memory,Swapping,Demand Paging,Page Table (Basic Idea),Translation Lookaside Buffer (TLB),Page Replacement Algorithms (First In First Out, List Recent Use, Optimal, Most Recent USe)	6 Hrs.
Unit 6	**I/O and File Management** File concepts, File organization,File operations,File directories, File System Implementation, I/O devices, Types and characteristics of devices, OS design issues for I/O management, Disk Structure, Disk scheduling algorithms: First Come First Serve, Shortest Seek Time First(SSTF), SCAN, C-SCAN, Swap Space Management	6 Hrs.

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Sr. No.	Textbooks
1.	William Stallings, Operating Systems: Internals and Design Principles, Pearson Publication, 8th Edition, 2018.
2	Remzi H. Arpaci-Dusseau and Andrea C. Arpaci-Dusseau, Operating Systems: Three Easy Pieces, CreateSpace Publication, 2018.
	Abraham Silberschatz, Peter B. Galvin and Greg Gagne, Operating System Concepts, Wiley Publication, 8th Edition, 2008.
Sr. No.	**Reference Books**
1.	Andrew S. Tanenbaum, Modern Operating System, PHI Publication, 4th Edition, 2015.
2.	D. M. Dhamdhere, Systems Programming and Operating Systems, McGraw-Hill, 2nd Edition, 1996.
3.	Garry Nutt, Operating Systems Concepts, Pearson Publication, 3rd Edition, 2003.
4.	Harvey M. Deitel, An Introduction to Operating Systems, Addison Wesley Publication, 2nd Edition, 1990.
5.	Thomas W. Doeppner, Operating System in Depth: Design and Programming, Wiley Publication, 2011
Sr. No.	**Web Resources**
1.	https://archive.nptel.ac.in/courses/106/105/106105214/
2.	https://onlinecourses.nptel.ac.in/noc21_cs72/preview
3.	Coursera:(https://www.coursera.org)
4.	https://codex.cs.yale.edu/avi/os-book/OS8/os8c/slide-dir/

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Course Title: Universal Human Values II **Course Code: GE253703**		**Course Category: VEC**
Teaching Scheme	**Examination Scheme**	
Lectures: 02 hrs. / Week	CA-1	10 Marks
Tutorial: -	CA-2	10 Marks
Credits: 02	MSE	20 Marks
Semester: Second Year (Semester III)	ESE	60 Marks
Course Prerequisite: Universal Human Values I		
Course Description: This course introduces the fundamentals of **value education**, focusing on self-exploration, human aspirations, and continuous happiness. It emphasizes harmony within the individual, in relationships, society, and nature. The course develops understanding of **human values, ethics, and professional responsibility**. It encourages students to adopt a **holistic and sustainable approach** to life and decision-making. Learners are guided to apply these values in personal and professional contexts.		
Course Objectives: 1. Explain the concept of value education, self-exploration, and the relationship between happiness, prosperity, and basic human aspirations. 2. Distinguish between the needs of self and the body and apply methods to achieve harmony within the individual and between the self and the body. 3. Demonstrate understanding of harmony in the family and society by applying foundational values such as trust and respect in human relationships. 4. Analyze the interconnectedness and mutual fulfilment among the four orders of nature and relate it to sustainable living and coexistence. 5. Apply a holistic understanding of human values to professional ethics, decision-making, and strategies for value-based life and profession.		

Course Outcomes:		
COs	**After completion of the course students will be able to**	**Bloom's Level**
CO1	**Define** the concepts of value education, human aspirations, harmony in human beings, family, society, nature and professional ethics.	Remember (Level 1)
CO2	**Explain** the role of self-exploration, human values, relationships and harmony in achieving continuous happiness and prosperity.	Understand (Level 2)
CO3	**Demonstrate** the interrelationship among human beings, society, nature and ethical conduct for universal human order.	Apply (Level 3)
CO4	**Distinguish** the human values and professional ethics in personal and professional life.	Analyze (Level 4)

CO-PO-PSO Mapping													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1						2	3	1			3		
CO2						2	3	2			3		
CO3						3	3	2			2		
CO4						3	3	3			3		

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Assessment	
CA-1 (a)	Subjective Test / Assignment/ MCQ Test
CA-2 (b)	Subjective Test / Assignment/ MCQ Test
MSE (c)	Subjective Test
ESE (d)	Exam

Course Contents		
Unit 1	**Introduction to Value Education:** Understanding Value Education, Self-exploration as the Process for Value Education, Continuous Happiness and Prosperity, the Basic Human Aspirations, Right Understanding, Relationship and Physical Facility, Happiness and Prosperity, Current Scenario, Method to Fulfill the Basic Human Aspirations.	4 Hrs.
Unit 2	**Harmony in the Human Being** Understanding human beings as the Co-existence of the Self and the Body, distinguishing between the Needs of the Self and the Body, Harmony of the Self with the Body, self-regulation, and Health.	4 Hrs.
Unit 3	**Harmony in the Family and Society:** Harmony in the Family, the Basic Unit of Human Interaction, Values in Human-to-Human Relationship, 'Trust' – the Foundational Value in Relationship, 'Respect'– as the Right Evaluation, Understanding Harmony in the Society, Vision for the Universal Human Order	4 Hrs.
Unit 4	**Harmony in Nature (Existence)** Understanding Harmony in Nature, Interconnectedness, self-regulation and Mutual Fulfillment among the Four Orders of Nature, Realizing Existence as Co-existence at All Levels, The Holistic Perception of Harmony in Existence.	4 Hrs.
Unit 5	**Implications of Holistic Understanding** Natural Acceptance of Human Values, Definitiveness of (Ethical) Human Conduct, A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order.	4 Hrs.
Unit 6	**Value-Based life and Professional Practices** Competence in Professional Ethics- Holistic Technologies, Production Systems and Management Models-Typical Case Studies, Strategies for Transition towards Value-based Life and Profession.	4 Hrs.

Sr. No.	Textbooks
1.	A Foundation Course in Human Values and Professional Ethics R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-47-1.
2.	Teachers' Manual for A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-53-2
Sr. No.	**Reference Books**
1.	Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2.	Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.

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3.	The Story of Stuff (Book).
4.	The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
5.	Small is Beautiful - E. F Schumacher.
6.	Slow is Beautiful - Cecile Andrews
7.	Economy of Permanence - J C Kumarappa
8.	Bharat Mein Angreji Raj - Pandit Sunderlal
9.	Rediscovering India - by Dharampal
10.	Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
11.	India Wins Freedom - Maulana Abdul Kalam Azad
12.	Vivekananda - Romain Rolland (English)
13.	Gandhi - Romain Rolland (English)
Sr. No.	**Web Resources**
1.	https://uhv.org.in/UHV-II_Course_Material

Course Title: Financial Management **Course Code: CS253704**	**Course Category: EM**

Teaching Scheme	**Examination Scheme**	
Lectures: 02 hrs. / week	CA-1	10 Marks
Tutorial: -	CA-2	10 Marks
Credits: 02	MSE	20 Marks
Semester: Second Year (Semester III)	ESE	60 Marks

Course Prerequisite:

- Basic Accounting Knowledge
- Mathematics and Analytical Skills , Economics Fundamentals, Business Studies Basics
- Computer Literacy and Critical Thinking and Decision-Making Skills.

Course Description: Financial Management provides a foundational understanding of how to plan, manage, and control an organization's financial resources effectively. The course covers essential topics such as financial analysis, investment and financing decisions, working capital management, and emerging trends in finance. Students will develop analytical and decision-making skills to address financial challenges and optimize organizational performance, preparing them for careers in finance, banking, and entrepreneurship.

Course Objectives:

1. A comprehensive understanding of financial management concepts and principles.
2. Skills to analyze financial statements for effective decision-making.
3. Techniques for evaluating investment opportunities and understanding risk-return trade-offs.
4. Knowledge of working capital management and financing decisions.
5. Insights into modern financial practices and emerging trends in finance.

Course Outcomes:		
COs	**After completion of the course students will be able to**	**Bloom's Level**
CO1	**Explain** the fundamental concepts of financial management, including objectives, roles of a finance manager, and key financial decisions.	Understand (Level 2)
CO2	**Implement** methods using various sources of finance and compute the cost of capital components,including cost of equity, debt, and WACC for decision-making.	Apply (Level 3)
CO3	**Examine** financial statements to evaluate business performance using ratio analysis techniques such as liquidity, solvency, profitability, and turnover ratios.	Analyze (Level 4)
CO4	**Assess** investment opportunities and working capital requirements using capital budgeting techniques and working capital management principles.	Evaluate (Level 5)

CO-PO-PSO Mapping

CO-PO-PSO Mapping													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	2	1	-	-	-	-	-	-	1	2	1	1	2
CO2	2	2	1	-	2	-	-	-	-	2	1	2	3
CO3	2	3	-	2	2	-	-	-	1	2	1	2	2
CO4	2	3	2	1	2	1	-	-	1	3	2	2	3

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Assessment	
CA-1 (a)	Subjective Test / Assignment/ MCQ Test etc.
CA-2 (b)	Subjective Test / Assignment/ MCQ Test etc.
MSE (c)	Subjective Test

Course Contents		
Unit 1	**Finance Management – Conceptual Foundations:** Introduction to Business Finance, Objectives of Financial Management, Roles and Responsibilities of Finance Manager, Finance Decisions: Investment Decision; Financing Decisions; and Dividend Decisions, Wealth maximization vs. profit maximization.	4 Hrs.
Unit 2	**Planning and Analysis:** Meaning and importance of financial planning, Introduction to Income Statement and Balance Sheet, Theoretical overview of Ratio-based analysis: liquidity, solvency, profitability, and turnover ratios.	4 Hrs.
Unit 3	**Sources of Finance and Cost of Capital:** Internal and External Financing: Concept and difference. Long-term and short-term sources of finance. Concept of cost of capital: cost of equity, cost of debt, preference shares, and weighted average cost of capital (WACC) – theoretical overview	4 Hrs.
Unit 4	**Capital Budgeting:** Meaning of Capital Budgeting, Nature and Characteristic, Importance, Objective, Capital Budgeting Techniques : Payback Period; Discounted Payback Period; IRR; ARR; NPV, Factors Affecting Capital Budgeting Decisions, Limitations of Capital Budgeting	4 Hrs.
Unit 5	**Working Capital :** Concept of working capital, operating cycle, Nature of working-capital, Types of Working Capital, Profitability v/s Liquidity, Inventory Management: Types, Motives of holding inventory, Cash Management- Motives of Holding Cash, Factors Determining Cash, Receivables in credit management. Brief overview of credit-policy decisions (collection period, credit terms).	4 Hrs.
Unit 6	**Working Capital Financing:** Meaning of Working Capital Financing, Need, Short term and long-term Financing, Trade Credit, Bank credit : OD; Term Loan; CC; Hypothecation Loan; Bill Discounting	4 Hrs.

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Sr. No.	Textbooks
1.	Financial Management I M Pandey (Vikas Publishing House), 11th Edition(2015)
2.	Financial Management -Prassana Chandra (Tata McGraw Hill), 11th Edition (2023)
3.	Financial Management -Rajiv Srivastava and Anil Mishra (Oxford University press), 2nd Edition (2011)
Sr. No.	**Reference Books**
1.	Financial Management Theory & Practice and Eugene F. Brigham/Michael C. Ehrhardt's, 17th Edition (2023)
2.	Fundamentals of Financial Management by James C. VanHorne, 13th Edition (2010)
3.	Financial Management: Text and Problems, MY Khan and PK Jain, 8th Edition (2008)
4.	Brealey and Myers., Principles of corporate finance (710h ed.), Tata McGraw Hill, 7th Edition(2003)
Sr. No.	**Web Resources**
1.	Corporate Finance---By Prof. Abhijeet Chandra IIT Kharagpur https://onlinecourses.nptel.ac.in/noc21_mg93/preview
2.	Financial Management for Managers—Prof. Anil K Sharma https://onlinecourses.nptel.ac.in/noc20_mg31/preview

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Course Title: Data Structures and Operating System Lab		
Course Code: CS253204L		**Course Category: PCC**
Teaching Scheme	**Examination Scheme**	
Practical/Sessions: 02 hrs. / week	CA-I	15 Marks
Credits: 01	CA-II	15 Marks
Semester: Second Year (Semester III)	ESE	20 Marks

Assessment	
CA-I (a) (15M)	As per practical evaluation sheet
CA-II (b) (15M)	As per practical evaluation sheet

Sr. No.	List of Experiments
1.	To design and implement one dimensional and two dimensional arrays to understand traversal, insertion, deletion and its memory address calculation.
2.	To implement a singly linked list and doubly linked list to understand its operations .
3.	To implement a stack using an array and linked list to understand its working principle.
4.	To implement a queue using an array and linked list to demonstrate its operations.
5.	To implement a circular queue using an array and linked list to demonstrate its operations.
6.	To implement operations on binary tree and binary search tree to understand its working principle.
7.	To implement and perform comparison of linear search and binary search to demonstrate the difference of their working.
8.	To implement and perform comparison of selection and insertion sort to understand their working principle.
9.	To study and implement basic system calls such as `getpid()` and `getppid()`, and to understand process creation and synchronization using `fork()` and `wait()` system calls.
10.	To design and implement CPU scheduling algorithms such as FCFS and SJF to understand process scheduling and performance parameters.
11.	To implement the Producer–Consumer synchronization problem to understand process synchronization using basic variables.
12.	To implement Banker's Algorithm to understand deadlock avoidance and safe resource allocation.
13.	To design and implement memory allocation algorithms such as First Fit and Best Fit to understand efficient memory utilization.
14.	To implement page replacement algorithms such as FIFO and LRU to understand page faults and memory management techniques.
15.	To study and implement virtualization using a virtual machine to understand resource sharing and system isolation.

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16.	To evaluate and compare the features, architecture, and functionalities of Windows and Linux operating systems.

Course Title: PBL: Problem based Learning
Course Code:CS253805 **Course Category: EL**

Teaching Scheme	Examination Scheme (As Applicable)	
Practicals/Sessions: 02 Hours/Week	CA-I	15 Marks
Credits: 01	CA-II	15 Marks
Semester: Second Year (Semester III)	ESE	20 Marks

Course Prerequisite:

- **Basic Computer Knowledge:** Understanding of fundamental computer operations such as file handling, operating systems, and using software applications. Familiarity with concepts like memory, input/output devices, and basic troubleshooting..
- **Logical and Analytical Thinking:** Ability to think logically and solve problems step-by-step. Basic understanding of algorithms, flowcharts, or problem-solving approaches is helpful.
- **Familiarity with Text Editors or IDEs:** Basic experience using tools like code editors (e.g., Notepad++, VS Code) or any Integrated Development Environment (IDE) is beneficial.
- **Design Thinking Module**

Course Description: This course enables students to learn engineering concepts through solving real-world course related technical problems at detailed project level. It emphasizes application of domain knowledge, critical thinking, and systematic problem-solving. In this course students will remain engaged in need identification, solution development, prototyping, and validation within given constraints. The course promotes teamwork and hands-on learning. Outcomes are demonstrated through a representational prototype of proposed solution along with detailed documentation. The course coordinators will guide to the students in the journey of problem solving by providing the resources in the lab activity sessions and also monitor the students progress.

Course Objectives:

1. To enable students to apply domain knowledge for solving real-world course related technical problems through a structured problem-based learning approach.
2. To guide students in analyzing problems, generating feasible solutions, and making informed engineering decisions.
3. To facilitate the development of design, implementation, and testing skills through project-based activities.
4. To cultivate teamwork, communication, and professional skills through continuous mentoring and evaluation.

Course Outcomes:

COs	After completion of the course student will be able to	Bloom's Level
CO1	**Understand** real-world engineering problems by identifying basic requirements, limitations, and relevant knowledge.	L2 Understand
CO2	**Apply** engineering concepts, tools, and methods to develop a working solution.	L3 Apply
CO3	**Analyze** engineering problems by connecting theory with practical situations and finding possible solution approaches.	L4 Analyze
CO4	**Evaluate** different engineering solutions based on factors like feasibility, cost, efficiency, and sustainability.	L5 Evaluate
CO5	**Create** and present engineering solutions by testing performance and explaining results clearly.	L6 Create

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CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	2		1								2	2
CO2	3	2	2	2	2			2			1	3	2
CO3	3	3	3	1	1			2			1	3	2
CO4	2	2	3	2	2	1		1			1	3	3
CO5			3		2			3	2	2	2		

Assessment	
CA-I (a)	Identify a real-life problem related to your subject. Clearly explain the problem, understand the needs of users, and list the important constraints (such as cost, materials, and time). Study existing solutions for the same problem. Then, generate different possible solutions and select the best one based on practicality, cost, and effectiveness.
CA-II (b)	Based on the selected solution, design and build a representational model of prototype. Prepare a proper plan, use suitable tools and methods to develop it. Make improvements if needed, and finally demonstrate the representational model with clear documentation.
ESE (c)	Assigned Task Completion.

Sr. No.	**List of Experiments/Activities**
1.	To identify a course-related technical problems.
2.	To define the problem clearly with objectives, basic requirements, and constraints.
3.	To study existing solutions or methods related to the problem and find the gap
4.	To generate different possible solutions using basic engineering concepts.
5.	To select the best solution based on different applicable criteria's i.e. feasibility, simplicity, and cost-effectiveness.

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6.	To prepare the design, list of materials and use the required tools for the solution.
7.	To develop a basic representational model of prototype using available resources.
8.	To test the developed solution based on the peer-reviewed feedback.
9.	To improve the solution based on test results and feedback.
10.	To present the final solution and prepare a simple technical report.

Sr. No.	Textbooks
1.	Nigel Cross,Design Thinking: Understanding How Designers Think and Work, Berg Publishers.
2.	Nigel Cross,Engineering Design Methods: Strategies for Product Design, John Wiley & Sons.
	Reference Books
1.	Guerra, Aida, Ulseth, Ronald, Kolmos, Anette, PBL in Engineering Education: International Perspectives on Curriculum Change, Springer, 2017.
	Web Resources
1.	NPTEL Online Courses- Problem Based learning, NITTTR. (https://onlinecourses.swayam2.ac.in/e-learning/preview/ntr20_ed12)

Course Title: Professional Development III **Course Code: GE253603**		**Course Category: VSE**
Teaching Scheme	**Examination Scheme**	
Practicals/Sessions: 02 Hours/Week	CA-I	15 Marks
Credits: 01	CA-II	15 Marks
Semester: Second Year (Semester III)	ESE	20 Marks
Course Prerequisite: Basic Computer Literacy, Mathematical Knowledge, Keyboard Skills.		
Course Description: This course introduces students to essential office productivity tools used for professional documentation, presentations, and data management. Students will learn to create and format documents using word processing software, design effective presentations using presentation tools, and organize and analyze data using spreadsheet applications. The course emphasizes hands-on practice with features such as formatting, charts, data validation, pivot tables, and spreadsheet functions. Through practical exercises, students will develop skills in preparing professional documents, visual presentations, and structured data sheets. The course is important for improving digital literacy and enabling students to efficiently handle academic, professional, and workplace documentation tasks.		
Course Objectives: 1. To introduce students to the fundamental features and tools of office productivity software used for document preparation, presentations, and spreadsheet management. 2. To provide practical exposure to creating, formatting, and presenting professional documents and presentations using appropriate digital tools. 3. To familiarize students with spreadsheet techniques for organizing, managing, and visualizing data using charts, tables, and formatting tools. 4. To develop digital competency by training students in spreadsheet functions, data validation, pivot tables, and other tools for efficient data handling and analysis in academic and professional environments.		

Course Outcomes:

COs	**After completion of the course, students will be able to**	**Bloom's Level**
CO1	**Recall** fundamental concepts, features, and interfaces of office productivity tools including word processing, presentation software, spreadsheets, and professional email communication.	Remember (Level 1)
CO2	**Explain** the working principles, functionalities, and best practices of word processing, presentation design, spreadsheet operations, and email writing etiquettes for professional communication.	Understand (Level 2)
CO3	**Apply** office productivity tools to create structured documents, professional emails, effective presentations, and organized spreadsheets using appropriate features and formatting techniques.	Apply (Level 3)
CO4	**Analyze** and **interpret** data using spreadsheet techniques such as charts, validation, pivot tables, and functions to support information processing and decision-making in real-world scenarios.	Analyze (Level 4)

CO-PO-PSO Mapping:

CO-PO-PSO Mapping													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	1	1	-	-	2	-	-	-	1	-	1	-	1
CO2	1	1	-	-	2	-	1	-	2	-	1	-	2
CO3	2	1	1	-	3	-	1	1	3	1	1	1	3

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CO4	2	3	1	2	3	-	-	1	2	1	2	2	3

Assessment	
CA-I (a)	Performance & Evaluation of activities on word & Presentation Module.
CA-II (b)	Performance & Evaluation of activities on spreadsheet Module
ESE (c)	Viva-voce/Activity Evaluation of different module.

Sr. No.	List of Experiments/Activities
1.	To explore word processor interface and navigation tools for efficient document handling and professional drafting.
2.	To apply basic text entry and formatting tools in word processor for creating structured documents.
3.	To apply advanced formatting techniques for consistency and improved presentation of created report.
4.	To create presentations using slides, themes, and multimedia elements for effective communication.
5.	To analyze and modify presentation designs using software tools for improving visual impact.
6.	To perform data entry and worksheet formatting in spreadsheet software for organized data management.
7.	To apply conditional formatting and create charts in spreadsheets for data visualization.
8.	To implement data validation and filtering techniques in spreadsheets for accurate data analysis.
9.	To generate pivot tables using spreadsheet tools for summarizing and analyzing large datasets.
10.	To apply spreadsheet functions (text, date-time, mathematical, statistical, and logical) for data processing and decision-making.
11.	To explore email significance, navigation tools and Id creation to inculcate essential principles.
12.	To compose professional emails using proper email writing etiquettes for effective workplace communication.

Sr. No.	Textbooks
1.	Abigail Rusu, Andrea Long, Heather Maye, Jennifer Evans, Amy Ledgerwood, and Jeanine Preuss, Introduction to Microsoft Office, Maricopa Millions Grant.
2.	Helen Holding, Clare Martin, Mastering Microsoft Office, Red Globe Press.
3.	R. P. Soni, Harshal Arolkar, Sonal Jain, Working with Personal Computer Software, Wiley India.

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	Reference Books
1.	Stephanie Krieger, Documents, Presentations, and Workbooks: Using Microsoft Office to Create Content That Gets Noticed, Microsoft Press.
2.	Marjorie S. Hunt, Barbara Clemens, Illustrated Microsoft Office 365 & Office 2016, Cengage Learning.
3.	Linda Foulkes, Learn Microsoft Office 2019, Packt Publishing.
	Web Resources
1.	Step-by-step learning resources for office software, https://www.tutorialspoint.com/word https://www.tutorialspoint.com/excel https://www.tutorialspoint.com/powerpoint
2.	Spreadsheet concepts and functions tutorials, https://www.w3schools.com/excel

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Course Title: Do It Yourself (DIY)		
Course Code: CS253804		**Course Category: EL**
Teaching Scheme	**Examination Scheme**	
Practical's /Sessions: 02 Hours/Week	CA-I	15 Marks
Credit: 1	CA-II	15 Marks
Semester: III	ESE	20 Marks

Course Prerequisite:
Basic knowledge of computer fundamentals, operating system concepts, and elementary networking concepts. Familiarity with handling computer hardware components and basic command-line usage will be helpful. This fits the practical activities on identifying computer components, OS installation, LAN setup, Wi-Fi setup, and Linux challenges.

Course Description:
This course provides hands-on exposure to essential computer systems, operating systems, and networking practices. It includes identification of computer hardware components, formatting storage devices, installation of operating systems, dual-boot setup, LAN cable preparation, peer-to-peer and star network configuration, wireless LAN setup using a Wi-Fi router, and Linux-based problem-solving activities.

Course Objective:

- To develop practical skills in computer hardware identification, operating system installation and configuration, basic wired and wireless networking, and Linux-based system handling through activity-based learning.

Course Outcomes:

COs	**After completion of the course students will be able to**	**Bloom's Level**
CO1	**Identify** the major components of a computer system and explain their basic functions in system operation.	Understand Level 2
CO2	**Perform** formatting of storage devices and install/configure single-boot and dual-boot operating systems as per given specifications.	Apply Level 3
CO3	**Prepare** and configure wired and wireless network setups, including LAN cables, peer-to-peer networks, star topology, switch-based LAN, and Wi-Fi router-based wireless LAN.	Apply Level 3
CO4	**Assess** and solve basic Linux-based system and networking challenges using appropriate commands, tools, and troubleshooting steps.	Analyze Level 4

CO-PO Mapping:

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	2	1	-	-	1	-	-	-	-	-	1	-	2
CO2	2	1	-	-	3	-	-	-	-	1	2	1	2
CO3	2	2	1	1	3	-	-	2	1	1	2	3	2
CO4	2	3	-	2	3	-	-	1	-	-	3	2	2

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Assessment	
CA-I (a) (15M)	Students will be assessed on their ability to identify computer system components and perform foundational system-related practical tasks, including formatting of storage devices, installation of operating systems, installation of dual boot operating systems, and preparation of straight-through and crossover LAN cables. Assessment will be based on correctness of procedure, successful execution, understanding of the activity performed, and viva/oral performance related to the practical work.
CA-II (b) (15M)	Students will be assessed on their ability to configure and demonstrate basic networking and Linux-related practical activities, including peer-to-peer network connection and file/folder sharing, implementation of star topology using a switch with resource sharing, physical LAN setup using a switch, wireless LAN configuration using a Wi-Fi router, and Linux-based challenge solving. Assessment will be based on practical execution, configuration accuracy, troubleshooting ability, demonstration of outcomes, and viva/oral performance.

Sr. No.	List of Activities
1.	Identify the different components of the computer system
2.	Demonstrate Formatting of HDD as per the Given Specifications and Installation of an Operating System
3.	Demonstrate Installation of Dual Boot Operating System
4.	Prepare a Straight Through and Crossover LAN Cable
5.	Prepare P2P Network Connection and Sharing of Files and Folders
6.	Prepare a Star Network Using a Switch and Sharing of Resources
7.	Prepare a Physical LAN Using a Switch
8.	Prepare a Wireless LAN Using a Wi-Fi Router
9.	Solving Linux based Challenge Part – 1
10.	Solving Linux based Challenge Part - 2

Sr. No.	Textbooks
1.	PC Hardware and A+ Handbook – Kate J. Chase
2.	Computer Networks – Andrew S. Tanenbaum
3.	Operating System Concepts – Abraham Silberschatz, Peter B. Galvin, Greg Gagne
4.	Linux Administration: A Beginner's Guide – Wale Soyinka
5.	Data Communications and Networking – Behrouz A. Forouzan
	Reference Books
1.	Upgrading and Repairing PCs – Scott Mueller
2.	UNIX and Linux System Administration Handbook – Evi Nemeth, Garth Snyder, Trent R. Hein, Ben Whaley
3.	The Linux Command Line – William E. Shotts Jr.
4.	Computer Networking: A Top-Down Approach – James F. Kurose, Keith W. Ross
5.	Linux Bible – Christopher Negus
	Web Resources
1.	https://ubuntu.com/tutorials
2.	https://www.linux.org/docs/
3.	https://www.kernel.org/doc/html/latest/
4.	https://www.cisco.com/c/en_in/training-events/networking-academy.html
5.	https://www.gnu.org/software/bash/manual/

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Course Title: Database System **Course Code: CS253401**		**Course Category: MDM-I**
Teaching Scheme	**Examination Scheme**	
Lectures: 02 hrs. / week	CA-1	10 Marks
Tutorial: –	CA-2	10 Marks
Credits: 02	MSE	20 Marks
Semester: Second Year (Semester III)	ESE	60 Marks

Course Prerequisite:

- **Computer Fundamentals**: Familiarity with operating system basics, such as processes and memory management. Understanding of File and File organization
- **Data Structure Basics**: Understanding of fundamental data structures such as arrays, linked lists, stacks, and queues. Knowledge of simple searching and sorting techniques.

Course Description: This course introduces the fundamentals of database systems, including data models, and Entity Relationship (ER) modeling. It develops skills in Structured Query Language (SQL) and Procedure language SQL (PL/SQL) for data management and covers normalization, transaction processing, and concurrency control. The course also provides an overview of NoSQL databases and modern data handling techniques for real-world applications

Course Objectives:

1. To learn and understand database system architecture, functioning and applications.
2. To understand representation of real-life objects or data elements and their relationship for a specified system using ER modeling to conceptualize design for the database.
3. To enable students to write SQL queries for data definition, manipulation, and retrieval along with normalization and transaction management techniques.
4. To provide exposure to NoSQL databases for modern data management.

Course Outcomes		
COs	**After completion of the course students will be able to:**	**Bloom's Level**
CO1	**Recall** basic concepts of database systems, database architecture, data models, and types of database languages.	Remember (Level 1)
CO2	**Explain** ER modeling concepts, relational database design, normalization forms, SQL query structure, integrity constraints, and NoSQL.	Understand (Level 2)
CO3	**Use** ER modeling techniques and SQL commands to design and implement relational databases and perform data manipulation.	Apply (Level 3)
CO4	**Illustrate** database design and transaction processing, SQL vs NoSQL, concurrency control, and recovery techniques.	Analyze (Level 4)

CO-PO-PSO Mapping													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	1	–	–	–	–	–	–	–	1	–		
CO2	3	2	1	–	1	–	–	–	–	1	–		
CO3	3	2	3	1	3	–	–	–	1	1	–		
CO4	3	3	2	2	2	–	–	–	–	1	–		

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Assessment	
CA-1 (a)	Subjective Test / Assignment/ MCQ Test etc.
CA-2 (b)	Subjective Test / Assignment/ MCQ Test etc.
MSE (c)	Subjective Test

Course Contents		
Unit 1	**Introduction to Database Systems** Database System Applications, Purpose of Database Systems, View of Data, Schemas and Instances, Overview of Database Languages, Database Architecture, Types of Data Models.	4 Hrs.
Unit 2	**Entity Relationship Modeling** Entity Relationship (ER) Model, Notation for ER Diagram, Constraints, Concepts of Super Key, Candidate Key, Primary Key, Weak Entity Sets, Codd's Rule, ER Diagrams, Mapping Cardinality, Extended ER Model, Generalization, Aggregation, Reduction of an ER Diagrams to Tables.	4 Hrs.
Unit 3	**Introduction to Structured Query Language** Overview of Structured Query Language (SQL), Database Languages, Basic Structure of SQL Queries, Integrity Constraints, Additional Basic Operators, Set Operations, Null Values, Aggregate Functions, Nested Sub Queries, Join, View, SQL Data Types, and Authorization.	4 Hrs.
Unit 4	**Relational Database Design** Relational Database Design Process: Features of Good Relational Designs and Functional Dependencies. Normalization: Normal Forms, First, Second, Third Normal Forms, Boyce Codd Normal Form (BCNF).	4 Hrs.
Unit 5	**NoSQL Databases** Introduction to NoSQL: Need, Features, Consistency, Availability, and Partition Tolerance (CAP) Theorem, Basically Available, Soft State, and Eventual Consistency (BASE) Properties, Types of Data: Structured, Unstructured Data and Semi-Structured Data, Comparative study of SQL and NoSQL. MongoDB (with syntax and usage): Working with Documents and Collections, MangoDB Methods, Indexing, Aggregation, MapReduce. Case Study: Use of NOSQL database for processing of unstructured data from social media.	4 Hrs.
Unit 6	**Transaction Processing** Transaction Concept, A simple Transaction Model, Atomicity, Consistency, Isolation, and Durability (ACID) Properties, ACID Vs BASE. Schedules: Serial Vs Parallel Schedule. Serializability: View and Conflict, Concurrency Control Techniques: Lock based Protocols, Deadlock Handling, Time stamp-Based Protocols, Recovery System.	4 Hrs.

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Sr. No.	Textbooks
1.	Henry Korth, Abraham Silberschatz & S. Sudarshan, Database System Concepts, McGraw-Hill Publication, 6th Edition, 2011.
2.	Navathe, Fundamentals of Database System, Addison-Wesley Publication, 6th Edition, 2012.
3.	MongoDB: The Definitive Guide, Kristina Chodorow, O'Reilly Media, 2nd Edition, 2013.
Sr. No.	**Reference Books**
1.	Thomas M. Connolly, Carolyn E. Begg, "Database Systems: A Practical Approach to Design, Implementation and Management", Addison Wesley,fifth Edition, 2014
2.	Raghu Ramakrishnan, Johannes Gehrke, Database Management Systems, McGraw-HillPublication, 3rd Edition, 2003
3.	Joel Murach, Murach's Oracle SQL and PL/SQL for Developers, Mike Murach & Associates,2nd Edition, 2014.
4.	C. J. Date "Introduction to Database Systems", Addition Wesley, Seventh Edition, 2000
5.	AtulKahate, "Introduction to Database Management System", Third Edition, Pearson Education, 2013
Sr. No.	**Web Resources**
1.	NPTEL course: Database management system (IITK): https://onlinecourses.nptel.ac.in/noc21_cs04/
2.	https://www.geeksforgeeks.org/dbms/dbms/
3.	NPTEL Course: https://onlinecourses.nptel.ac.in/noc26_cs39/preview

Course Title: Principles of Programming Languages **Course Code: CS253205**		**Course Category: HMM-I**
Teaching Scheme	**Examination Scheme**	
Lectures: 02 hrs. / week	CA-1	10 Marks
Tutorial: -	CA-2	10 Marks
Credits: 02	MSE	20 Marks
Semester: Second Year (Semester III)	ESE	60 Marks

Course Prerequisite:

- Basic knowledge of linear algebra (vectors, matrices, complex numbers).
- Understanding of digital logic design (logic gates, Boolean algebra, circuits).
- Fundamentals of programming (Python or C language) and basic computational concepts.

Course Description:

This course provides an in-depth understanding of programming language concepts, paradigms, and implementation techniques. It emphasizes formal syntax and semantics, abstraction mechanisms, and comparative analysis of programming paradigms including imperative, object-oriented, functional, and logic programming. Advanced topics such as concurrency, scripting, and modern language features are explored through problem-based learning and case studies.

Course Objectives:

1. To understand the evolution and design principles of programming languages.
2. To analyze syntax and semantics using formal methods.
3. To explore multiple programming paradigms and their applications.
4. To design solutions using appropriate abstraction mechanisms.
5. To evaluate modern language features including concurrency and scripting.

Course Outcomes		
COs	**After completion of the course students will be able to:**	**Bloom's Level**
CO1	**Recall** basic concepts of programming languages.	Remember (Level 1)
CO2	**Explain** programming paradigms, design criteria, and type systems.	Understand (Level 2)
CO3	**Implement** programming language concepts to construct program elements.	Apply (Level 3)
CO4	**Examine** bindings, scope, and abstraction mechanisms.	Analyze (Level 4)
CO5	**Assess** programming paradigms for effective problem solving.	Evaluate (Level 5)

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CO-PO-PSO Mapping

CO-PO-PSO Mapping													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	2	1	-	-	-	-	-	-	-	2	-	1
CO2	3	3	-	2	2	-	-	-	-	-	2	1	2
CO3	2	2	2	-	2	-	-	1	-	-	2	3	3
CO4	3	2	3	2	2	-	-	1	1	1	2	2	2
CO5	2	2	2	2	3	1	-	1	1	1	3	2	2

Assessment	
CA-1 (a)	Subjective Test / Assignment/ MCQ Test etc.
CA-2 (b)	Subjective Test / Assignment/ MCQ Test etc.
MSE (c)	Subjective Test

Course Contents		
Unit 1	**Foundations of Programming Languages** Evolution of programming languages, Role and Need of Programming Languages in Software Development, Programming paradigms:Imperative, Object Oriented Programming, Functional, Logic, Language design criteria: readability, writability, reliability.	4 Hrs.
Unit 2	**Syntax, Semantics and Data Types** Syntax and semantics, Formal Syntax: Context-Free Grammars (CFG): Basic rules, derivations, Attribute Grammars, Basic concept Data Types, Type Systems.	4 Hrs.
Unit 3	**Names, Bindings and Control Structures** Names, Variables, Identifiers, Bindings and Scope: Static and Dynamic, Lifetime of Variables: Static, Stack, Heap allocation, Expressions and Statements, Control Structures: Selection, Iteration, Error Handling Mechanisms.	4 Hrs.
Unit 4	**Subprograms and Abstraction** Subprograms: Procedures and Functions, Parameter Passing Techniques, Recursion and Activation Records (stack frames), Abstract Data Types (ADT), Encapsulation and Modularity, Generic Programming Concepts.	4 Hrs.
Unit 5	**Object-Oriented and Concurrent Programming** OOP concepts: classes, objects, inheritance, polymorphism, Encapsulation and information hiding, Exception handling mechanisms, Concurrency concepts: processes, threads, Synchronization: semaphores, monitors, Deadlocks and mutual exclusion.	4 Hrs.
Unit 6	**Logic Programming and Modern Trends** LISP Basics: Lists, Recursion, Evaluation, Logic Programming (Prolog): Facts, Rules, Queries ,Inference Mechanism, Backtracking, Scripting Languages (Python): Dynamic Typing, Memory Management, Modules and Libraries, Emerging Trends: Parallel Programming, Domain-Specific Language	4 Hrs.

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Sr. No.	Textbooks
1.	Principles of Programming Languages Version 1.0.4 by Mike Grant Zachary Palmer Scott Smith, 2020.
2.	Concepts of Programming Languages – Robert W. Sebesta, 10th Edition, Pearson Education, 2012.
3.	Principles of Programming Languages by M. Archan, 2023.
4.	Programming Languages: Concepts and Constructs – Ravi Sethi, 2nd Edition, Pearson Education, 2000.
Sr. No.	**Reference Books**
1.	Programming Language Design Concepts – David A. Watt, Wiley India, 1st Edition 2024.
2.	Programming Languages: Principles and Practice – Kenneth C. Louden, Cengage Learning, 3rd Edition, 2012.
3.	Programming Languages – Allen B. Tucker & Robert E. Noonan, Tata McGraw-Hill, 1st Edition, 2012.
4.	Programming Language Concepts – Carlo Ghezzi & Mehdi Jazayeri, Wiley India, 3rd Edition, 2008.
5.	Introduction to Programming Languages – Arvind Kumar Bansal, CRC Press, 1st Edition, 2014.
Sr. No.	**Web Resources**
1.	www.nptel.iitm.ac.in/video.php?subjectId=106102067
2.	www.cs.cmu.edu/~rwh/courses/ppl/
3.	http://www.apl.jhu.edu/~hall/lisp.html
4.	http://www.swi-prolog.org/pldoc/refman/

Course Title: Software Design and Modeling **Course Code: CS253206**	**Course Category: DM-I (Track I)**	
Teaching Scheme	**Examination Scheme**	
Lectures: 02 hrs. / week	CA-1	10 Marks
Tutorial: –	CA-2	10 Marks
Credits: 02	MSE	20 Marks
Semester: Second Year	ESE	60 Marks

Course Prerequisite: Basic knowledge of **programming concepts** (preferably in languages like C, C++, or Java),Understanding of **data structures and algorithms**
Familiarity with **object-oriented programming (OOP) concepts** (class, object, inheritance, polymorphism),Basic understanding of **software engineering concepts** (SDLC, requirements, testing),Fundamental knowledge of **computer systems and databases** *(desirable)*

Course Description: This course introduces the fundamentals of software design and modeling using object-oriented concepts and UML. It focuses on analyzing requirements, designing system architectures, and developing static and dynamic models for real-world software applications.

Course Objectives:

1. To understand fundamental concepts of **software design, modeling, and architecture**
2. To learn and apply **object-oriented principles and UML diagrams** for system modeling
3. To analyze software requirements and design appropriate system architectures
4. To develop **static and dynamic models** using UML techniques
5. To apply **design patterns and architectural styles** in software development
6. To design efficient, scalable, and maintainable software solutions for real-world problems

Course Outcomes		
COs	**After completion of the course students will be able to:**	**Bloom's Level**
CO1	**Recall** fundamental software modeling concepts, UML elements, and basic design principles.	Remember (Level 1)
CO2	**Explain** and interpret software requirements, UML diagrams, and architectural concepts.	Understand (Level 2)
CO3	**Use** static and dynamic models for software systems using UML techniques.	Apply (Level 3)
CO4	**Use** architectural patterns and modeling methods to construct software design solutions.	Apply (Level 3)

CO-PO-PSO Mapping													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	2	1	-	-	-	-	-	-	-	-	1	1	2
CO2	2	2	1	-	1	-	-	-	1	-	1	2	2
CO3	2	2	2	1	2	-	-	1	1	-	-	3	2
CO4	3	2	3	1	2	1	-	1	1	1	1	3	2

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Assessment	
CA-1 (a)	Subjective Test / Assignment/ MCQ Test etc.
CA-2 (b)	Subjective Test / Assignment/ MCQ Test etc.
MSE (c)	Subjective Test

Course Contents		
Unit 1	**Introduction to Software Modeling** Software Modeling,Object-Oriented Methods and UML,Software Architectural Design,Method and Notation,COMET Method,UML as a Standard,Multiple Views of Software Architecture,Evolution of Software Modeling and Design Methods,Overview of Concurrent, Distributed, and Real-Time Design Methods	4 Hrs.
Unit 2	**UML Notation and Software Processes** UML Diagrams Overview,Use Case Diagrams,Classes and Objects,Class Diagrams,Interaction Diagrams,State Machine Diagrams,Packages and Deployment Diagrams,UML Extension Mechanisms,Software Life Cycle Models,Verification & Validation,Software Testing	4 Hrs.
Unit 3	**Software Design Concepts and Use Case Modeling** Object-Oriented Concepts,Information Hiding,Inheritance and Generalization,Concurrent Processing,Design Patterns,Software Architecture Components,Software Quality Attributes,Requirements Modeling,Use Case Modeling (Actors, Relationships: Include & Extend),Activity Diagrams	4Hrs.
Unit 4	**Static and Dynamic Modeling** Static Modeling (Associations, Aggregation, Composition), Generalization / Specialization Hierarchies,Constraints in UML,System Context Modeling,UML Stereotypes,Object and Class Structuring(Boundary, Entity, Control Classes),Dynamic Interaction Modeling,Message Sequencing,Stateless Interaction Modeling	4Hrs.
Unit 5	**Behavioral Modeling and Advanced Interaction** Finite State Machines,State Transitions and Statecharts,Events, Guard Conditions,Actions,Hierarchical Statecharts,Developing Statecharts from Use Cases,State-Dependent Interaction Modeling,Interaction Diagrams with Statecharts,Example: Banking System	4 Hrs.
Unit 6	**Software Architecture and Case Studies** Overview of Software Architecture,Architectural Patterns,Component-Based Architecture,Client-Server Architecture,Service-Oriented Architecture (SOA),Concurrent and Real-Time Architectures,Software Quality Attributes (Performance, Security, Scalability, etc.)Case Studies:Banking System,Component-Based Systems,Real-Time Systems	4 Hrs.

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Sr. No.	Textbooks
1.	Hassan Gomaa,Software Modeling and Design: UML, Use Cases, Patterns, and Software Architectures,Cambridge University Press, 2011
2	James R Rumbaugh, Michael R. Blaha.Object-Oriented Modeling and Design with UML.2005
Sr. No.	**Reference Books**
1.	UML Distilled – Martin Fowler 2003
2.	Applying UML and Patterns – Craig Larman 2015
Sr. No.	**Web Resources**
1.	Lucidchart, https://www.lucidchart.com
2.	GeeksforGeeks,https://www.geeksforgeeks.org
3.	Visual Paradigm,https://www.visual-paradigm.com

Course Title: Client-Side Technologies and Frameworks **Course Code: CS253207**	**Course Category: DM-I (Track 2)**

Teaching Scheme	**Examination Scheme**	
Lectures: 02 hrs. / week	CA-1	10 Marks
Tutorial: -	CA-2	10 Marks
Credits: 02	MSE	20 Marks
Semester: Second Year (Semester III)	ESE	60 Marks

Course Prerequisite:

- Basic knowledge of programming.

Course Description: This course provides a comprehensive foundation in client-side web technologies and modern front-end frameworks. It covers HTML5 for structuring content, CSS for styling and responsive design, and JavaScript with DOM for building interactive web pages. Students explore jQuery and AJAX for dynamic data handling, and develop applications using React.js with hooks. The course also introduces Bootstrap and Next.js to create scalable, responsive, and high-performance web interfaces through practical case studies and real-world applications.

Course Objectives:

The objective of this course is to provide the students with:

1. Fundamental knowledge of web designing.
2. Basics of JavaScript for client-side processing.
3. Explore React.js library for front-end enhancement.
4. Learn frameworks for rapid web development.

Course Outcomes:		
COs	**After completion of the course students will be able to**	**Bloom's Level**
CO1	**Organize** HTML and CSS tags to construct meaningful web pages.	Analyze (Level 4)
CO2	**Use** JavaScript and jQuery for web-page manipulations and AJAX for asynchronous form validations.	Apply (Level 3)
CO3	**Use** the React.js library for developing interactive UI components.	Apply (Level 3)
CO4	**Illustrate** the frameworks for rapid client-side development.	Analyze (Level 4)

CO-PO-PSO Mapping

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	1	-	3	-	2	-	-	-	-	-	2	2	1
CO2	1	-	3	-	3	-	-	-	-	-	2	2	1
CO3	1	-	3	-	3	-	-	-	-	-	2	2	1
CO4	-	-	2	-	3	-	-	-	-	-	2	1	1

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Assessment	
CA-1 (a)	Subjective Test / Assignment/ MCQ Test etc.
CA-2 (b)	Subjective Test / Assignment/ MCQ Test etc.
MSE (c)	Subjective Test

Course Contents		
Unit 1	**Web Designing Fundamentals** Role of client-side in web architecture, HTTP request and response messages, web clients, web servers, Introduction to markup languages, HTML page structure. HTML5 elements: Text formatting and structuring elements, form component elements and attributes, semantic elements, media tags.	4 Hrs.
Unit 2	**Cascading Style Sheet** Introduction to style sheet, CSS features, CSS core syntax, CSS selectors, CSS inclusion methods, style rule cascading and inheritance, shorthand CSS properties for text, background, border. Case study on use of CSS by W3Schools in its own W3.CSS framework.	4 Hrs.
Unit 3	**JavaScript and DOM** JavaScript: Introduction to JavaScript, JavaScript real-world applications, JavaScript basic syntax, JavaScript fundamentals concepts and core data structures, built in objects. DOM: Introduction to Document Object Model, DOM levels, the document tree, intrinsic event handling, finding HTML elements, modifying element attributes and style, DOM event handling.	4 Hrs.
Unit 4	**jQuery and AJAX** jQuery library: element selection, the css() method, element manipulation with jQuery. AJAX: Introduction to AJAX, synchronous vs. asynchronous communication, XHR object configuration, DOM Manipulation with AJAX, using jQuery with AJAX. Case study on working of AJAX for real-world form validation.	4 Hrs.
Unit 5	**React.js Essentials** Introduction to React.js, component-based architecture, JSX syntax and coding constructs, rendering HTML elements with JSX, React components, conditionals, props, lists, forms, events. React Hooks- useState, useEffect, useContext, useReducer. Case study on working of any Todo list based on React.js.	4 Hrs.
Unit 6	**Advanced Client-Side Frameworks** Bootstrap: Bootstrap as a responsive front-end UI framework, CDN vs npm installation, Bootstrap page structure, bootstrap layout structure and responsive design concepts, built-in UI components-buttons, alerts, forms, navbars, cards. Next.js: Introduction to Next.js, features of Next.js, installation and project structure, routing in Next.js, creating reusable UI components. Case study on real-world application of data rendering using props.	4 Hrs.

Sr. No.	Textbooks
1.	Jeffrey C. Jackson, Web Technologies: A Computer Science Perspective, 2007, Second Edition, Pearson Education, ISBN 978-0131856035.
2.	Alex Banks and Eve Porcello , Learning React, 2020, Second Edition, O'Reilly publication, ISBN- 978-1492051725.

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3.	Jake Spurlock, Bootstrap, 2013, First Edition, O'Reilly publication, ISBN- 9781449343910.
Sr. No.	**Reference Books**
1.	Marty Hall, Larry Brown, Core Web Programming, 2001, Second Edition, Pearson Education, ISBN- 978-0130897930.
2.	Michele Riva, Real-World Next.js, 2022, First Edition, Packt Publishing, ISBN-978-1801073493.
Sr. No.	**Web Resources**
1.	NPTEL course: Web Technologies by Dr. S. Sasirekha, National Institute of Technical Teachers' Training and Research, Chennai https://onlinecourses.swayam2.ac.in/ntr25_ed123/preview
2.	NPTEL course: Web Technology by Dr. Ashutosh Kumar Bhatt, Uttarakhand Open University, Haldwani https://onlinecourses.swayam2.ac.in/nou25_cs23/preview

Course Title: Object Oriented Programming using JAVA
Course Code: CS254208 **Course Category: PCC**

Teaching Scheme	Examination Scheme	
Lectures: 03 hrs. / week	CA-1	10 Marks
Tutorial: -	CA-2	10 Marks
Credits: 03	MSE	20 Marks
Semester: Second Year (Semester IV)	ESE	60 Marks

Course Prerequisite:

- Programming Fundamentals:Basics of programming language.

Course Description: This course provides a detailed introduction to Java programming, covering its architecture, object-oriented principles, and features like Java Virtual Machine (JVM), bytecode and Just-In-Time(JIT) compiler. It explores class fundamentals, inheritance, arrays, strings and advanced concepts such as packages, interfaces, and exception handling. Students will learn Java Database Connectivity (JDBC) for database integration. The course includes GUI development using Swing, with a focus on components, containers, event handling and layout management.

Course Objectives:

1. To understand the core concepts of Java programming, including object-oriented principles, JVM architecture and key features like bytecode and the JIT compiler.
2. To develop proficiency in creating and managing classes, objects, inheritance, exception handling for building robust and reusable applications.
3. To enable students to use Java packages, interfaces and JDBC for modular programming and database connectivity in real-world scenarios.
4. To equip students with skills to design graphical user interfaces using Swing components, containers and event handling mechanisms.

Course Outcomes

COs	After completion of the course students will be able to:	Bloom's Level
CO1	**Recall** and Define fundamental Java concepts	Remember (Level 1)
CO2	**Explain** arrays, vectors, strings, wrapper classes and package concepts using Java	Understand (Level 2)
CO3	**Implement** inheritance, method overriding, abstract classes, interfaces, and multiple inheritance concepts to design reusable Java programs	Apply (Level 3)
CO4	**Test** types of errors and exceptions, analyze exception hierarchy, and implement exception handling using try, catch, finally, throw, and throws	Analyze (Level 4)
CO5	**Design** and implement database connectivity using JDBC components	Create (Level 6)
CO6	**Develop** event-driven GUI applications using Java Swing	Create (Level 6)

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Assessment	
CA-1 (a)	Subjective Test / Assignment/ MCQ Test etc.
CA-2 (b)	Subjective Test / Assignment/ Mini Application/ MCQ Test etc.
MSE (c)	Subjective Test

CO-PO-PSO Mapping													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	1	-	-	-	-	-	-	-	-	1	3	2
CO2	3	2	-	-	1	-	-	-	-	-	1	3	3
CO3	3	2	2	-	2	-	-	1	-	-	1	3	3
CO4	2	3	-	2	2	-	-	-	-	-	1	3	3
CO5	3	2	3	2	3	1	-	1	-	1	1	3	3
CO6	3	2	3	1	3	1	-	2	-	1	1	3	3

Course Contents		
Unit 1	**Introduction to Java Applications** Features of Java, Java Virtual Machine, Byte Code, JIT Compiler, Class fundamentals, Declaring Objects, Nested and Inner Classes, Introducing Methods,Constructors, Garbage Collection, Overloading Methods, Using Objects as Parameters, Returning Objects, Access Control.	6 Hrs.
Unit 2	**Arrays and Packages** Arrays, Vectors,Strings, Wrapper classes, Using Command-Line Arguments, Packages: Defining a Package and types, Finding Packages and CLASSPATH, A Short Package Example, Access Protection, Importing Packages, Study of java.lang & java.util packages.	6 Hrs.
Unit 3	**Inheritance and Polymorphism** Inheritance Basics, Using Super, Method Overriding, Abstract Classes, Using final Keyword with Inheritance, Interfaces: Defining an Interface, Implementing Interfaces, Variables in Interfaces, Extending Interfaces, Multiple Inheritance.	6 Hrs.
Unit 4	**Exception Handling** Types of Errors, Exception Hierarchy, Built-in Exceptions, User-defined Exceptions, Arithmetic Exception, InputMismatch Exception, Exception Handling using try, catch, finally, throw and throws keyword.	6 Hrs.
Unit 5	**Java Database Connectivity** Introduction,Types of JDBC Drivers, Driver interface and Driver Manager class, Connection Interface, Statement Interface, Prepared Statement, ResultSet, JDBC Program for executing Statements and processing Result Set, Using Prepared Statement.	6 Hrs.

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Unit 6	**Swing** Introduction to Swing, Swing Architecture, Swing Components: JLabel, JTextField, JTextArea, JButton, JCheckBox, Containers and layout managers FlowLayout, BorderLayout and GridLayout. Event handling: ActionListener, menus, dialog boxes, and basic graphics in Swing.	6 Hrs.

Sr. No.	Textbooks
1.	E Balagurusamy, Programming with Java, Tata Mc Graw Hill, 4th edition, 2010
2.	Kathy sierra and bert bates,Head first java**,** Third Edition, 2022
Sr. No.	**Reference Books**
1.	Herbert Schildt, Java The Complete Reference, McGraw-Hill Publication, 9thEdition, 2014.
2.	Steven Holzner, Java 2 Black Book,DreamTech Press, 2008.
3.	Patrick Niemeyer, Daniel Leuck, Learning Java, O'Reilly Media, 4th Edition, 2013.
4.	Bruce Eckel, Thinking in Java by,6th Edition,2006.
Sr. No.	**Web Resources**
1.	https://www.javatpoint.com/java-swing
2.	https://docs.oracle.com/javase/tutorial
3.	https://www.geeksforgeeks.org/java
4.	https://www.tutorialspoint.com/swing/index.htm

Course Title: Computer Architecture and Organization **Course Code: CS254209**	**Course Category: PCC**	
Teaching Scheme	**Examination Scheme**	
Lectures: 03 hrs. / week	CA-1	10 Marks
Tutorial: -	CA-2	10 Marks
Credits: 03	MSE	20 Marks
Semester: Second Year (Semester IV)	ESE	60 Marks

Course Prerequisite: Fundamentals of Computers

Course Description: This course offers a comprehensive introduction to computer architecture and organization, enabling participants to understand how computer systems work. Concepts are illustrated using examples from a popular Reduced Instruction Set Computer (RISC) platform. Beginning with fundamentals, the course explores state-of-the-art developments, supported by practical examples and illustrations to effectively convey key concepts and challenges.

Course Objectives:

1. To understand the fundamentals of computer organization and architecture, including CPU structure and functions.
2. To learn instruction sets, addressing modes, and program execution in RISC and CISC architectures.
3. To gain knowledge of computer arithmetic, memory organization, and storage systems.
4. To understand control units, input/output organization, pipelining, and parallel processing concepts for modern computer systems.

Course Outcomes:		
COs	**After completion of the course students will be able to:**	**Bloom's Level**
CO1	**Define** the fundamentals of computer organization and CPU architecture	Remember (Level 1)
CO2	**Explain** instruction sets, addressing modes, and program execution in RISC and CISC architectures	Understand (Level 2)
CO3	**Demonstrate** concepts of computer arithmetic, memory organization, and storage systems to solve computational problems	Apply (Level 3)
CO4	**Examine** the structure and performance of control units, I/O organization, pipelining, and parallel processing techniques.	Analyze (Level 4)

CO-PO-PSO Mapping													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	1	-	-	-	-	-	-	-	-	1	2	1
CO2	3	2	-	-	-	-	-	-	-	-	1	2	1
CO3	3	3	2	1	2	-	-	-	-	-	2	3	2
CO4	3	3	2	2	2	1	-	-	-	-	2	3	2

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Assessment	
CA-1 (a)	Subjective Test / Assignment/ MCQ Test etc.
CA-2 (b)	Subjective Test / Assignment/ MCQ Test etc.
MSE (c)	Subjective Test / Assignment/ MCQ Test etc.

Course Contents		
Unit 1	**Introduction:** Concept of computer organization and Architecture, Fundamental unit, Computer function and interconnection, CPU structure and function	6 Hrs.
Unit 2	**Instruction Sets:** Characteristics, Types of operands, Types of operations, Assembly language, Addressing modes, Instruction format, Types of instruction, Instruction execution, Machine state and processor status, Structure of program, Introduction to RISC (Reduced Instruction Set Computer) and CISC (Complex Instruction Set Computer) architecture	6 Hrs.
Unit 3	**Computer Arithmetic:** The arithmetic and logic Unit, Integer representation, Integer arithmetic, Floating point representation, Floating point arithmetic, Introduction of arithmetic co-processor	6 Hrs.
Unit 4	**Memory Organization:** Internal Memory: Semiconductor main memory, Error correction, Advanced DRAM (Dynamic Random Access Memory) organization, Virtual memory systems and cache memory systems. External Memory:Organization and characteristics of magnetic disk, Magnetic tape, Optical memory, RAID (Redundant Array of Independent Disks), Memory controllers.	6 Hrs.
Unit 5	**Control Unit:** Control unit operation: Micro-operations, Hardwired implementation, Microprogrammed Control Unit, Basic concepts, Micro-instruction sequencing, Micro-instruction execution, Applications of micro-programming.	6 Hrs.
Unit 6	**Input/Output Organization:** External devices, I/O module, Programmed I/O, Interrupt driven I/O, Direct memory access, I/O channels and processors, External interface, Instruction pipelining: Concepts. Parallel processing: Multiple processor organization, Cache coherence and the MESI protocol.	6 Hrs.

Sr. No.	Textbooks
1.	William Stalling, Computer Organization and Architecture: Designing for Performance, Prentice Hall Publication, 8th Edition, 2009
2.	Hayes, Computer Architecture and Organization, McGraw-Hill Publication, 3rd Edition, 2012.
3.	Zaky, Computer Organization, McGraw-Hill Publication, 5th Edition, 2011.
Sr. No.	**Reference Books**
1.	Hennessy and Patterson, Computer Architecture: A Quantitative Approach, Morgan and Kaufman Publication, 4th Edition, 2007
2.	MostafaAbd-El-Barr, Hesham El-Rewini, Fundamentals of Computer Organization and Architecture, Wiley Publication, 1st Edition, 2004.
3.	Miles J. Murdocca, Vincent P. Heuring, Computer Architecture and Organization: An Integrated Approach, Wiley Publication, 1st Edition, 2007

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Sr. No.	Web Resources
1.	https://nptel.ac.in/courses/106102157
2.	https://nptel.ac.in/courses/106105163
3.	https://onlinecourses.nptel.ac.in/noc22_cs88

Course Title: Database Management System **Course Code: CS254210**		**Course Category: PCC**
Teaching Scheme	**Examination Scheme**	
Lectures: 03 hrs. / week	CA-1	10 Marks
Tutorial: -	CA-2	10 Marks
Credits: 03	MSE	20 Marks
Semester: Second Year (Semester IV)	ESE	60 Marks

Course Prerequisite:

- **Computer Fundamentals**: Familiarity with operating system basics, such as processes and memory management. Understanding of File and file organization
- **Data Structure Basics**: Understanding of fundamental data structures such as arrays, linked lists, stacks, and queues. Knowledge of simple searching and sorting techniques.

Course Description: This course introduces the fundamentals of database systems, including data models, and Entity Relationship (ER) modeling. It develops skills in Structured Query Language (SQL) and Procedure Language SQL (PL/SQL) for data management and covers normalization, transaction processing, and concurrency control. The course also provides an overview of NoSQL databases and modern data handling techniques for real-world applications.

Course Objectives:

1. To learn and understand database system architecture, functioning and applications.
2. To understand representation of real life objects or data elements and their relationship for a specified system using (Entity Relationship) ER modeling to conceptualize design for the database.
3. To enable students to write SQL queries for data definition, manipulation, and retrieval.
4. To impart knowledge of normalization and transaction management techniques.
5. To provide exposure to PL/SQL programming and NoSQL databases for modern data management.

Course Outcomes:

COs	**After completion of the course students will be able to**	**Bloom's Level**
CO1	**Recall** basic concepts of database systems, ER modeling, and SQL.	Remember (Level 1)
CO2	**Explain** database design, normalization, and SQL concepts including PL/SQL, NoSQL.	Understand (Level 2)
CO3	**Implement** sql queries, joins, subqueries, and PL/SQL constructs to perform data manipulation and database operations.	Apply (Level 3)
CO4	**Examine** relational schemas using normalization and dependency, and transaction management concepts including concurrency control.	Analyze (Level 4)
CO5	**Assess** different database models, ACID properties, concurrency techniques, and compare RDBMS with NoSQL databases.	Evaluate (Level 5)
CO6	**Design** and develop database applications using ER modeling, SQL, PL/SQL, and NoSQL techniques for real-world problems.	Create (Level 6)

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CO-PO-PSO Mapping													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	1	-	-	-	-	-	-	-	-	-	2	-
CO2	3	2	-	-	1	-	-	-	-	-	-	2	-
CO3	3	3	2	-	2	-	-	-	-	-	-	3	1
CO4	3	3	2	2	1	-	-	-	-	-	-	3	1
CO5	2	3		2	1	-	-	-	-	-	-	2	2
CO6	3	3	3	2	2	-	-	1	1	1	1	3	3

Assessment	
CA-1 (a)	Subjective Test / Assignment/ MCQ Test etc.
CA-2 (b)	Subjective Test / Assignment/ MCQ Test etc.
MSE (c)	Subjective Test

Course Contents		
Unit 1	**Introduction and Entity Relationship Modeling** Database System Applications, Purpose of Database Systems, View of Data, Schemas and Instances, Overview of Database Languages, Database Architecture, Types of Data Models, Entity Relationship (ER) Model, Notation for ER Diagram, Constraints, Super Key, Candidate Key, Primary Key, Weak Entity Sets, Codd's Rule, ER Diagrams, Mapping Cardinality, Extended ER Model, Generalization, Aggregation, Reduction of an ER Diagrams to Tables.	6 Hrs.
Unit 2	**Introduction to Structured Query Language** Overview of Structured Query Language (SQL), Database Languages, Basic Structure of SQL Queries, Integrity Constraints, Additional Basic Operators, Set Operations, Null Values, Aggregate Functions, Nested Sub queries, Modification of the Database, Intermediate SQ : Join Expressions, View, Integrity Constraints, SQL Data Types and Authorization.	6 Hrs.
Unit 3	**Relational Database Design** Relational database management system (RDBMS) Design Process: Features of Good Relational Designs, Functional Dependencies. Normalization: Normal Forms, First, Second, Third Normal Forms, Boyce-Codd Normal Form (BCNF), Multivalued Dependencies, Fourth Normal Form.	6 Hrs.
Unit 4	**Procedural Language / Structured Query Language (PL/SQL)** Overview of PL/SQL, Structure of PL/SQL block (DECLARE, BEGIN, EXCEPTION, END),Conditional and Iterative Control Statement (if-else, loop), Concept of Stored Procedures and Functions, Exception Handling, Cursors, Triggers, Assertions, Roles and Privileges.	6 Hrs.
Unit 5	**NoSQL Databases** Introduction to NoSQL: Need, Features, Consistency, Availability, and Partition Tolerance (CAP) Theorem, Basically Available, Soft state, and	

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	Eventual consistency (BASE) Properties, Types of Data: Structured, Unstructured Data and Semi-Structured Data, Comparative study of SQL and NoSQL. MongoDB (with syntax and usage): Working with Documents and Collections, MangoDB Methods, Indexing, Aggregation, MapReduce. Case Study: Use of NOSQL database for processing of unstructured data from social media.	
Unit 6	**Transaction Processing** Transaction Concept, A simple Transaction Model, Atomicity, Consistency, Isolation, and Durability (ACID) Properties, ACID and BASE properties. Schedules: Serial schedules, Parallel Schedule. Serializability: View and Conflict, Concurrency Control Techniques: Lock based Protocols, Deadlock Handling, Time stamp-Based Protocols, Recovery System.	6 Hrs.

Sr. No.	Textbooks
1.	Henry Korth, Abraham Silberschatz & S. Sudarshan, Database System Concepts, McGraw-Hill Publication, 6th Edition, 2011.
2.	Navathe, Fundamentals of Database System, Addison-Wesley Publication, 6th Edition, 2012.
3.	MongoDB: The Definitive Guide, Kristina Chodorow, O'Reilly Media, 2nd Edition, 2013.
Sr. No.	**Reference Books**
1.	Thomas M. Connolly, Carolyn E. Begg, "Database Systems: A Practical Approach to Design, Implementation and Management", Addison Wesley,fifth Edition, 2014
2.	Raghu Ramakrishnan, Johannes Gehrke, Database Management Systems, McGraw-HillPublication, 3rd Edition, 2003
3.	Joel Murach, Murach's Oracle SQL and PL/SQL for Developers, Mike Murach & Associates,2nd Edition, 2014.
4.	C. J. Date "Introduction to Database Systems", Addition Wesley, Seventh Edition, 2000
5.	AtulKahate, "Introduction to Database Management System", Third Edition, Pearson Education, 2013
Sr. No.	**Web Resources**
1.	NPTEL course : Database management system(IITK): https://onlinecourses.nptel.ac.in/noc21_cs04/
2.	https://www.geeksforgeeks.org/dbms/dbms/
3.	NPTEL Course: https://onlinecourses.nptel.ac.in/noc26_cs39/preview

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Course Title: Modern Indian Language II
Course Code: GE254705 **Course Category: HSSM-AEC**

Teaching Scheme	Examination Scheme	
व्याख्याने (Lectures): ०२ तास/आठवडा (02 hrs / week)	CA-1	10 Marks
ट्युटोरियल (Tutorial): -	CA-2	10 Marks
श्रेयांक (Credits): 02	MSE	20 Marks
सत्र (Semester): द्वितीय वर्ष (सत्र ४) (Second Year (Semester IV))	ESE	60 Marks

Course Prerequisite: देवनागरी लिपी वाचण्याचे आणि लिहिण्याचे प्राथमिक ज्ञान

Course Description:

हा अभ्यासक्रम सर्व शाखांच्या अभियंत्यांना मराठी भाषेचे व्यावहारिक आणि उद्योगभिमुख ज्ञान प्रदान करण्यासाठी तयार करण्यात आला आहे. यामध्ये विद्यार्थी मराठी भाषेचा इतिहास आणि व्याकरणाचा भक्कम पाया रचतील आणि त्यानंतर आकलन कौशल्ये व शब्दसंपत्ती वाढवण्यावर लक्ष केंद्रित करतील. हा अभ्यासक्रम प्रामुख्याने व्यावसायिक उपयोजनावर भर देतो, ज्यामध्ये अधिकृत पत्रव्यवहार, इतिवृत्त लेखन आणि अचूक पारिभाषिक व प्रशासकीय संज्ञांचा वापर शिकवला जाईल. याव्यतिरिक्त, तांत्रिक संकल्पनांचे अचूक संप्रेषण सुनिश्चित करण्यासाठी विद्यार्थी इंग्रजी आणि मराठी या दोन्ही भाषांमधील भाषांतर कौशल्ये विकसित करतील. सरतेशेवटी, हा अभ्यासक्रम भावी अभियंत्यांना स्थानिक उद्योग, कॉर्पोरेट क्षेत्र आणि शासकीय कार्यालयांमध्ये आत्मविश्वासाने आणि प्रभावीपणे संवाद साधण्यास सक्षम बनवतो.

Course Objectives:

1. विद्यार्थ्यांना मराठी भाषेचा उगम, विकास, देवनागरी लिपी आणि विविध साहित्य प्रकारांची ओळख करून देणे.
2. विद्यार्थ्यांना मराठी व्याकरणाचे मूलभूत नियम, शुद्धलेखन आणि अचूक वाक्यरचना यांचे सखोल ज्ञान देणे.
3. विद्यार्थ्यांची शब्दसंपत्ती वाढवणे आणि दैनंदिन तसेच व्यावसायिक संवादात वाक्प्रचार व म्हणींचा योग्य वापर करण्यास शिकवणे.
4. विद्यार्थ्यांमध्ये तांत्रिक आणि प्रशासकीय उताऱ्यांचे वाचन, विश्लेषण आणि अचूक आकलन करण्याची क्षमता विकसित करणे.
5. विद्यार्थ्यांना कार्यालयीन कामकाज, पत्रव्यवहार आणि अभियांत्रिकी क्षेत्रात वापरल्या जाणाऱ्या पारिभाषिक संज्ञांचे व्यावहारिक प्रशिक्षण देणे.
6. विद्यार्थ्यांना भाषांतराची तत्त्वे आणि पद्धती समजावून सांगणे आणि इंग्रजी-मराठी भाषांतराचा (विशेषतः तांत्रिक संदर्भात) सराव करून घेणे.

Course Outcomes:

COs	अभ्यासक्रम पूर्ण झाल्यानंतर विद्यार्थी सक्षम असतील (**After completion of the course students will be able to**)	Bloom's Level
CO1	मराठीचा इतिहास आणि विकास, मराठी व्याकरण, शब्दसंपत्ती आणि भाषासमृद्धी, आकलन कौशल्ये, व्यावहारिक आणि उपयोजित मराठी आणि भाषांतर कौशल्ये यांच्याशी संबंधित मूलभूत तथ्ये, माहिती, नियम आणि मानकांचे स्मरण करणे.	स्मरण Remember (Level 1)
CO2	मराठीचा इतिहास आणि विकास, मराठी व्याकरण, शब्दसंपत्ती आणि भाषासमृद्धी, आकलन कौशल्ये, व्यावहारिक आणि उपयोजित मराठी आणि भाषांतर कौशल्ये	समज

	यांच्याशी संबंधित विविध संकल्पना, रचना, आशय आणि कार्यपद्धती स्पष्ट करणे.	Understand (Level 2)
CO3	मराठीचा इतिहास आणि विकास, मराठी व्याकरण, शब्दसंपत्ती आणि भाषासमृद्धी, आकलन कौशल्ये, व्यावहारिक आणि उपयोजित मराठी आणि भाषांतर कौशल्ये यांमधील शिकलेल्या नियमांचे, तत्त्वांचे आणि कौशल्यांचे प्रत्यक्ष कामकाजात उपयोजन करणे.	उपयोजन Apply (Level 3)

CO-PO-PSO Mapping													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1						1			2		1		
CO2						1			2		1		
CO3						2			2		1		

Assessment	
CA-1 (a)	**वर्णनात्मक चाचणी / गृहपाठ / बहुपर्यायी प्रश्न चाचणी इत्यादी.** (Subjective Test / Assignment / MCQ Test etc.)
CA-2 (b)	**वर्णनात्मक चाचणी / गृहपाठ / बहुपर्यायी प्रश्न चाचणी इत्यादी.** (Subjective Test / Assignment / MCQ Test etc.)
MSE (c)	**वर्णनात्मक चाचणी** (Subjective Test)
ESE (d)	**अंतिम सत्र परीक्षा** (End Semester Exam)

Course Contents		
Unit 1	**मराठीचा इतिहास आणि विकास (History and Literature of Marathi)** मराठी भाषेचा उगम (Origin of Marathi Language), मराठी भाषेचा विकास (Development of Marathi Language), विविध मराठी साहित्य प्रकारांचा परिचय (Introduction to Various Marathi Literary Forms), प्रसिद्ध मराठी साहित्यिक (Famous Marathi Authors), निवडक साहित्यकृतींचा परिचय (Introduction to Selected Literary Works).	4 Hrs.
Unit 2	**मराठी व्याकरण (Marathi Grammar)** मराठी वर्णमाला (Marathi Alphabet), शब्दांच्या जाती (Parts of Speech), काळांचे प्रकार (Types of Tenses), अचूक वाक्यरचना (Correct Sentence Formation), शुद्धलेखनाचे नियम (Rules of Orthography/Spelling), विरामचिन्हांचा योग्य वापर (Proper Use of Punctuation).	4 Hrs.

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Unit 3	**शब्दसंपत्ती आणि भाषासमृद्धी (Vocabulary Building)** समानार्थी शब्द (Synonyms), विरुद्धार्थी शब्द (Antonyms), शब्दांची उत्पत्ती: तत्सम, तद्भव, देशी शब्द (Word Origin), शुद्ध आणि अशुद्ध शब्दांची ओळख व दुरुस्ती (Identifying and Correcting Spelling Errors), दैनंदिन संवादात म्हणींचा वापर (Use of Proverbs in Daily Communication), वाक्प्रचारांचा वापर (Use of Idioms).	4 Hrs.
Unit 4	**आकलन कौशल्ये (Reading & Comprehension)** दिलेल्या उताऱ्याचे वाचन, विश्लेषण आणि त्यावरील प्रश्नांची अचूक उत्तरे लिहिणे (Reading, Analysis, and Answering Questions on a Given Passage), तांत्रिक किंवा प्रशासकीय उताऱ्यांचे वाचन आणि सारांश लेखन (Reading technical or administrative passages in Marathi and summarizing them).	4 Hrs.
Unit 5	**व्यावहारिक आणि उपयोजित मराठी (Practical & Applied Marathi)** औपचारिक पत्रे (Formal Letters), इतिवृत्त लेखन (Meeting Minutes Writing), पारिभाषिक संज्ञा (Technical Terminology), अभियांत्रिकी कामात वापरले जाणारे इंग्रजी-मराठी शब्द (English-Marathi Words Used in Engineering Work), प्रशासकीय कामात वापरले जाणारे इंग्रजी-मराठी शब्द (English-Marathi Words Used in Administrative Work).	4 Hrs.
Unit 6	**भाषांतर कौशल्ये (Translation Skills)** भाषांतराची तत्त्वे (Principles of Translation), भाषांतराच्या पद्धती (Methods of Translation), शब्दशः भाषांतर (Literal Translation), आशयनिष्ठ भाषांतर (Contextual/Sense Translation), मराठीतून इंग्रजीत भाषांतर (Marathi to English Translation), इंग्रजीतून मराठीत भाषांतर (English to Marathi Translation).	4 Hrs.

Sr. No.	Textbooks
1.	मो. रा. वाळिंबे, सुगम मराठी व्याकरण व लेखन, नितीन प्रकाशन.
2.	डॉ. ल. रा. नसिराबादकर, व्यावहारिक मराठी, फडके प्रकाशन.
Sr. No.	**Reference Books**
1.	यास्मिन शेख, मराठी लेखन मार्गदर्शिका, पद्मगंधा प्रकाशन.
2.	डॉ. स्नेहल तावरे, व्यावहारिक मराठी, स्नेहवर्धन प्रकाशन.
3.	भाषा संचालनालय, शासन व्यवहार कोश, महाराष्ट्र शासन.
4.	डॉ. कल्याण काळे, डॉ. अंजली सोमण, भाषांतर मीमांसा, प्रतिमा प्रकाशन
5.	अ. ना. देशपांडे, मराठी साहित्याचा इतिहास (खंड १ आणि २), व्हीनस प्रकाशन.
6.	शब्दकोश आणि शास्त्रीय व तांत्रिक परिभाषा कोश, महाराष्ट्र राज्य साहित्य आणि संस्कृती मंडळ.
7.	कृ. पां. कुलकर्णी, मराठी भाषा: उद्गम व विकास, मेहता पब्लिशिंग हाऊस.
Sr. No.	**Web Resources**
1.	महाराष्ट्र शासन, भाषा संचालनालय (Directorate of Languages, Govt. of Maharashtra): https://languages.maharashtra.gov.in
2.	राज्य मराठी विकास संस्था (RMVS): https://rmvs.maharashtra.gov.in

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3.	मराठी विश्वकोश (Marathi Vishwakosh): https://marathivishwakosh.org
4.	भारत वाणी (Bharatavani Portal): https://bharatavani.in
5.	महाराष्ट्र राज्य साहित्य आणि संस्कृती मंडळ: https://sahitya.marathi.gov.in

Course Title: Entrepreneurship Development **Course Code: CS254706**	**Course Category: HSSM-EEM**	
Teaching Scheme	**Examination Scheme**	
Lectures: 02 hrs. / week	CA-1	10 Marks
Tutorial: –	CA-2	10 Marks
Credits: 02	MSE	20 Marks
Semester: Second Year (Semester IV)	ESE	60 Marks

Course Prerequisite: Students are expected to have basic knowledge of management principles, economics, and general business environment. Familiarity with problem-solving approaches and analytical thinking will support understanding of entrepreneurial concepts and practices.

Course Description: This course provides a comprehensive understanding of entrepreneurship, including entrepreneurial characteristics, motivation, and development programs. It emphasizes business idea generation, project planning, feasibility analysis, and financial aspects. The course also covers MSME development, government policies, and societal responsibilities to prepare students for entrepreneurial and managerial roles.

Course Objectives:

- Understand basic concepts and theories of entrepreneurship.
- To analyze the entrepreneurial environment and opportunities.
- To apply project planning and financial analysis techniques.
- To develop business ideas considering MSME and societal aspects.

Course Outcomes:		
COs	**After completion of the course students will be able to**	**Bloom's Level**
CO1	**Explain** concepts, characteristics, and theories of entrepreneurship and motivation.	Understand (Level 2)
CO2	**Implement** project planning techniques and evaluate feasibility, profit, and risk of business ideas.	Apply (Level 3)
CO3	**Examine** entrepreneurial environment, opportunities, and EDPs	Analyze (Level 4)
CO4	**Develop** business plans considering MSME, government policies, and societal responsibilities.	Create (Level 6)

CO-PO-PSO Mapping

CO-PO-PSO Mapping													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	2	-	-	-	2	2	-	-	-	2	-	2
CO2	3	3	3	2	2	-	-	-	-	3	-	2	-
CO3	-	3	-	-	-	3	-	2	2	-	3	-	2
CO4	-	-	3	-	-	3	3	2	3	3	2	-	3

Assessment	
CA-1 (a)	Subjective Test / Assignment/ MCQ Test etc.
CA-2 (b)	Subjective Test / Assignment/ MCQ Test etc.
MSE (c)	Subjective Test

Course Contents		
Unit 1	**Introduction to Entrepreneurship:** Entrepreneurship: concept and importance, Characteristics of successful entrepreneurs, Types of entrepreneurs, Entrepreneur vs Intrapreneur, Role of entrepreneurship in economic development, Basic legal aspects of entrepreneurship.	4 Hrs.
Unit 2	**Creativity, Innovation and Opportunity Identification:** Creativity and innovation in entrepreneurship, Idea generation techniques, Basic idea screening, Opportunity recognition, Feasibility analysis: market, technical, financial, and legal.	4 Hrs.
Unit 3	**Business Plan Development:** Business Model Canvas: concept; Value proposition; Customer segments; Revenue streams; Cost structure, Minimum viable product (MVP), Customer validation, Revenue models, Break-even analysis, Introduction to marketing management.	4 Hrs.
Unit 4	**Startup Ecosystem and Funding:** Startup ecosystem in India, Role of incubators and accelerators, Sources of startup funding: Banks, Bootstrapping; Angel investors; Incubation Programs, Venture capital, Government schemes like Startup India, Pradhan Mantri Mudra Yojana (PMMY), Technology Incubation and Development of Entrepreneurs (TIDE 2.0), Credit Guarantee Fund Trust for Micro and Small Enterprises (CGTMSE).	4 Hrs.
Unit 5	**Startup Management and Case Studies:** Entrepreneurial leadership and teamwork, Risk and uncertainty in startups, Intellectual property basics, Ethical and sustainable entrepreneurship, Startup pitching, Case studies of successful startups	4 Hrs.
Unit 6	**Entrepreneurial Support System:** Role of central and state government, District Industries Centre (DIC), Maharashtra Centre for Entrepreneurship Development (MCED), National Institute for Entrepreneurship and Small Business Development (NIESBUD) in Entrepreneurship Development.	4 Hrs.

Sr. No.	Textbooks
1.	Introduction to Entrepreneurship Development – Abhik Kumar Mukherjee & Shaunak Roy, OUP India, 2023.
2.	Vasant Desai, Dynamics of Entrepreneurship Development, Himalaya Publication house, 6th Edition, 2022.
3.	Taneja, Satish, Entrepreneurship Development, Himalaya Publishing House, 2010.

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4.	Khanka S.S., Entrepreneurial Development, S. Chand Co. Ltd., New Delhi, 2001.
Sr. No.	**Reference Books**
1.	Saravanavel, P.: Entrepreneurial Development, Margham Publication, Chennai. (2020)
2.	Mohanty, Fundamentals of Entrepreneurship, PHI Learning. 2009.
3.	Entrepreneurship: Business and Management – Dr. R.C. Bhatia, Sultan Chand & Sons, 2021.
Sr. No.	**Web Resources**
1.	https://nptel.ac.in/courses/106105183 Covers OSI model, switching techniques, and performance in detail
2.	https://onlinecourses.nptel.ac.in/noc26_mg11/preview
3.	https://onlinecourses.swayam2.ac.in/e-learning/preview/cec26_cm11

Course Title: Environmental and Sustainable Engineering **Course Code: CS254707**	**Course Category: VEC**	
Teaching Scheme	**Examination Scheme**	
Lectures: 02 hrs / week	CA-1	10 Marks
Tutorial: -	CA-2	10 Marks
Credits: 02	MSE	20 Marks
Semester: Second Year (Semester IV)	ESE	60 Marks

Course Prerequisite:
Basic knowledge of science (physics, chemistry basics)
Fundamental understanding of engineering concepts
Awareness of environmental issues and energy usage.

Course Description:
This course consists of different energy resources, environmental issues, and sustainable development. It also covers conventional and renewable energy systems, including solar, wind and hydropower, along with their working principles and applications. The course also covers environmental pollution and its causes, effects, and control measures. It also involves solid waste management techniques. Emphasis is given to sustainability concepts such as life cycle assessment, green technologies, and environmental impact assessment. Additionally, the course explores sustainable design practices, energy-efficient systems, e-waste management, and global initiatives like the United Nations Sustainable Development Goals (SDGs).

Course Objectives:

- To introduce concepts of energy resources and environmental impacts.
- To understand renewable energy systems and their applications.
- To develop knowledge of pollution control and waste management techniques
- To familiarize with sustainability principles and assessment tools (EIA)
- To promote awareness of sustainable design, green technologies, and SDGs

Course Outcomes:

COs	**After completion of the course: Students will be able to**	**Bloom's Level**
CO1	**Define** basic concepts of energy and environment.	Remember (Level 1)
CO2	**Identify** energy systems, environmental issues, and sustainability principles.	Understand (Level 2)
CO3	**Describe** methods for renewable energy use and pollution control.	Understand (Level 2)
CO4	**Apply** methods to address environmental impacts and sustainable solutions.	Apply (Level 3)

CO-PO Mapping

CO-PO Mapping													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	1	-	-	-	1	-	-	-	-	1	1	-
CO2	3	2	1	-	-	2	-	-	-	-	1	1	-
CO3	3	3	2	1	-	3	-	1	-	-	2	1	1
CO4	2	3	2	2	-	3	-	1	-	-	2	1	-

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Assessment	
CA-1 (a)	Subjective Test / Assignment/ MCQ Test etc.
CA-2 (b)	Subjective Test / Assignment/ MCQ Test/ Case study/ PPT etc.
MSE (c)	Subjective Test
ESE (d)	Exam

Course Contents		
Unit 1	**Energy and Environmental Studies** Introduction, Renewable and Non-renewable Energy Resources, Global Energy Scenario, Indian Energy Scenario, Energy demand and environmental impacts: Climate Change; Global Warming; Necessity of Decarbonization; Carbon Foot Printing Basics.	4 Hrs.
Unit 2	**Solar Energy Systems** Introduction, Solar radiation fundamentals and measurement, Operational Principles of Flat-plate and Concentrating Solar Thermal Collectors, Solar photovoltaic (PV) systems: principles and components, Design basics of solar PV systems, Applications: Rooftop Systems; Solar Pumps; Street Lighting.	4 Hrs.
Unit 3	**Renewable Energy Sources** Introduction, Basic Working Principles and Plant Layout: Wind Energy; Nuclear Energy; Biomass Energy; Hydropower; Geothermal; Tidal Energy.	4 Hrs.
Unit 4	**Environmental Pollution and Control** Introduction, Environmental Pollution: Definition, Cause, Effects & Control Measures of Air Pollution; Water Pollution; Soil Pollution; Marine Pollution, Solid Waste Management: Landfill; Incineration; Composting.	4 Hrs.
Unit 5	**Sustainable Engineering** Introduction, Principles of Sustainability, Life Cycle Assessment (LCA), Green Technology and Green Business, Sustainable Materials and Manufacturing, Sustainable Agriculture, Environmental Impact Assessment (EIA).	4 Hrs.
Unit 6	**Sustainable Design and Development** Introduction, Energy-Efficient Machines and Thermal Systems, E- Waste Reduction and Recycling, Green Computing and Data Center Efficiency , United Nations Sustainable Development Goals (SDGs).	4 Hrs.

Sr. No.	Textbooks
1.	G. D. Rai, Non-Conventional Energy Sources, Khanna Publishers
2.	B. H. Khan, Non-Conventional Energy Resources, McGraw Hill Education
3.	C. S. Rao, Environmental Pollution Control Engineering, New Age International
4.	Bhavik R. Bakshi, Sustainable Engineering: Principles & Practice, Cambridge University Press
	Reference Books
1.	S. P. Sukhatme and J.K. Nayak, Solar Energy: Principles of Thermal Collection and Storage, Tata McGraw Hill
2.	D. P. Kothari, K. C. Singal and Rakesh Ranjan, Renewable Energy Sources and Emerging Technologies, PHI Learning
3.	R. C. Gaur, Basic Environmental Engineering, New Age International

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4.	D. L. Reeg, Industrial Energy Conservation, Pergamon Press
5.	Catherine N. Mulligan, Sustainable Engineering:Principles & Implementation, CRC Press
6.	Kailas L. Wasewar and Sunita Neti Rao, Sustainable Engineering, Energy & the Environment, CRC Press
	Web Resources
1.	Prof. Vaibhav Vasant Goud and Prof. R. Anandalakshmi, Renewable Energy Engineering: Solar, Wind and Biomass Energy Systems, IIT Guwahati (https://nptel.ac.in/courses/103103206)
2.	Prof. P. Mondal, Basic Environmental Engineering and Pollution Abatement, IIT Roorkee (https://nptel.ac.in/courses/103107215)
3.	Prof. Prasanta Kumar Das and Prof. A Bhattacharya, Energy Conservation and Waste Heat Recovery, IIT Kharagpur (https://nptel.ac.in/courses/112105221)
4.	Prof. Brajesh Kumar Dubey, Sustainable Engineering Concepts and Life Cycle Analysis, IIT Kharagpur (https://onlinecourses.nptel.ac.in/noc21_ce47/preview)

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Course Title: Object Oriented Programming using JAVA and Database Systems Lab Course Code: CS254211L		Course Category: PCC
Teaching Scheme	**Examination Scheme**	
Practical/Sessions: 02 Hours/Week	CA-1	15 Marks
Credits: 01	CA-2	15 Marks
Semester: Second Year (Semester IV)	ESE	20 Marks

Assessment	
CA-I (a)	As per practical evaluation sheet
CA-II (b)	As per practical evaluation sheet

Sr. No.	List of Experiments
1.	Write a program to demonstrate basic syntactical constructs of java. A. Operators & Expressions B. Decision Making Statement C. Looping Statement
2.	Write a program to define a class, describe its constructor & overload its constructor.
3.	Write a program to Implement Array & Package.
4.	Write a program to implement different types of inheritances and polymorphism.
5.	Write a program to implement interfaces.
6.	Write a program to implement exception handling using built-in & user defined exceptions.
7.	Develop a Java Program for Handling Database Transactions Using JDBC.
8.	Implementation of a Graphical User Interface (GUI) Application using Java Swing Components and Event Handling.
9.	Study and Implementation of DDL commands and Integrity constraints.
10.	Study and Implementation of DML commands (SELECT/UPDATE/DELETE with GROUP BY, ORDER BY).
11.	Study and Implementation of advanced queries (nested subqueries,set operations, aggregate functions and JOIN).
12.	Create and manipulate Views and implement access control using GRANT and REVOKE (DCL/TCL).
13.	Write PL/SQL programs using conditional statements, loops, and exception handling.
14.	Study and Implementation of Cursors and Triggers.
15.	Install and configure the MongoDB environment. Perform CRUD operations in MongoDB.
16.	Implement Indexing, Aggregation operations, MapReduce operations in MongoDB.

Course Title: PBL: Problem to Project based Learning **Course Code: CS254807**		**Course Category: EL**
Teaching Scheme	**Examination Scheme (As Applicable)**	
Practicals/Sessions: 02 Hours/Week	CA-I	15 Marks
Credits: 01	CA-II	15 Marks
Semester: Second Year (Semester IV)	ESE	20 Marks

Course Prerequisite: Use of analytical skills and drawing tools, Design Thinking Module, Course Level-Problem Based Learning.

Course Description: This course extends problem-based learning into project realization, where students convert identified problems into working engineering solutions. It emphasizes design, development, and validation of mini-project prototypes using domain knowledge. Students apply systematic engineering approaches to build functional systems within constraints. The course promotes innovation, teamwork, and hands-on skills. Outcomes are demonstrated through a working prototype and technical presentation. The course coordinators will guide to the students in the journey of problem solving by providing the resources in the lab activity sessions and also monitor the students progress.

Course Objectives:

1. To guide students in transforming identified problems into implementable engineering solutions.
2. To facilitate the design, development, and testing of working prototypes using domain knowledge.
3. To mentor students in applying systematic engineering and project management approaches.
4. To develop students technical competency, teamwork, and communication through mini-project execution.

Course Outcomes:

COs	**After completion of the course: Student will be able to**	**Bloom's Level**
CO1	**Interpret** engineering problems and establish solution requirements in a practical context	L2 Understand
CO2	**Apply** suitable tools and techniques to develop a working model or prototype.	L3 Apply
CO3	**Analyze** and formulate solution strategies using relevant engineering principles	L4 Analyze
CO4	**Evaluate** alternative approaches and select appropriate design solutions	L5 Evaluate
CO5	**Develop** a functional working prototype using suitable tools and techniques	L6 Create

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CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	2		1								2	2
CO2	3	2	2	2	2			2			1	3	2
CO3	3	3	3	1	1						1	3	2
CO4	2	2	3	2	2	1		1			1	3	3
CO5			3		2			3	2	2	2		

Assessment	
CA-I (a)	Identify a real-life problem related to the course, clearly explain it with its needs and limitations, study existing solutions, suggest different possible solutions, and choose the best one based on cost, simplicity, and practicality.
CA-II (b)	Design a working model using suitable tools, test its performance, improve it based on results, and finally present the working solution with a simple report.
ESE (c)	Assigned Task Completion.

Sr. No.	**List of Experiments/Activities**
1.	To identify an open-ended problem related to the course for the mini-project.
2.	To define the problem with its objectives, basic requirements, and limitations.
3.	Literature review/survey of existing solutions and understand their drawbacks.
4.	To identify different possible solutions using course-related concepts.
5.	To select the best solution based on different criteria i.e. simplicity, cost, and practicality.
6.	To prepare the design, list of materials and use the required tools for the solution.
7.	To build a basic working model or prototype using available resources.

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8.	To test the model and check whether it meets the expected results.
9.	To improve the model based on testing results and feedback.
10.	To present the final mini-project with a simple report including method, results, and conclusion.

Sr. No.	Textbooks
1.	Nigel Cross,Design Thinking: Understanding How Designers Think and Work, Berg Publishers.
2.	Karl T. Ulrich, Steven D. Eppinger, Product Design and Development, McGraw-Hill Education.
	Reference Books
1.	Mahnaz MoallemWoei Hung Nada Dabbagh, The Wiley Handbook of Problem-Based Learning, Wiley, 2019.
2.	Kothari, C. R., & Garg, Research Methodology: Methods and Techniques, 2nd Revised Edition, 2019- New Age International Publishers, New Delhi.
	Web Resources
1.	NPTEL Online Courses- Problem Based learning, NITTTR. (https://onlinecourses.swayam2.ac.in/e-learning/preview/ntr20_ed12)

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Course Title: Professional Development-IV **Course Code: CS254604**	**Course Category: VSE**

Teaching Scheme	**Examination Scheme**	
Practical/Sessions: 02 hrs. / week	CA-1	15 Marks
Credits: 01	CA-2	15 Marks
Semester: Second Year (Semester IV)	ESE	20 Marks

Course Prerequisite:

- Basic programming.
- Problem-solving skills.
- Understand OOP fundamentals.
- Familiarity with Online Coding Platforms.

Course Description: This course focuses on developing problem-solving skills using fundamental data structures and algorithms through hands-on coding practice. It covers key concepts like arrays, strings, recursion, stacks, queues, linked lists, and sorting/searching techniques. Students learn to write efficient programs by understanding time and space complexity. Practical implementation using platforms like HackerRank enhances coding proficiency and logical thinking.

Course Objectives:

1. To strengthen students programming and problem-solving skills through structured coding practice.
2. To introduce fundamental data structures such as arrays, stacks, queues, and linked lists.
3. To develop understanding of recursion, searching, and sorting algorithms.
4. To enable students to analyze program efficiency using time and space complexity.
5. To provide hands-on experience in solving real-world problems using platforms like HackerRank.

Course Outcomes:		
COs	**After completion of the course students will be able to**	**Bloom's Level**
CO1	**Explain** basic programming concepts such as if-else, loops, arrays, strings, and simple problem-solving techniques.	Understand [Level 2]
CO2	**Implement** recursion, string methods, and array operations for solving structured programming problems efficiently.	Apply [Level 3]
CO3	**Analyze** data structures like stack, queue, and linked list along with their operations and use cases.	Analyze [Level 4]
CO4	**Evaluate** efficient solutions using searching & sorting algorithms, time-space complexity, BST, file handling, and STL concepts.	Evaluate [Level 5]

CO-PO-PSO Mapping:

CO-PO-PSO Mapping													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	2	1	-	-	1	-	-	-	1	-	1	2	2
CO2	3	2	1	-	3	-	-	1	1	-	1	2	2
CO3	3	3	2	2	2	-	-	1	1	-	2	3	2
CO4	3	3	2	3	3	1	-	-	1	1	2	3	3

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Assessment	
CA-1 (a)	CA-1 evaluates students' understanding of basic programming, arrays, strings, and recursion through practical coding tasks.
CA-2 (b)	CA-2 assesses students ability to implement data structures and apply sorting and searching techniques efficiently.
ESE (c)	ESE evaluates overall understanding through viva-voce and practical problem-solving activities.

Sr.No.	List of Activities
1.	To understand programming concepts, OOPJ, and time-space complexity through basic warm-up exercises like if-else, loops, digit counting, patterns, and string reversal for problem-solving skills.
2.	To implement array operations like removing duplicates, element deletion, string reversal, and single number identification on HackerRank for improving problem-solving skills.
3.	To apply string and string methods for efficient text manipulation and problem-solving.
4.	To implement recursion techniques for solving problems such as Fibonacci series, factorial, and palindrome checking to enhance logical thinking and problem-solving skills.
5.	To implement stack operations and explore types of queues with their operations for understanding linear data structures and their applications.
6.	To understand and implement different types of linked lists and their operations for efficient dynamic data management.
7.	To implement and analyze searching and sorting algorithms along with file handling and binary search tree operations for efficient data organization and problem-solving.
8.	To explore Standard Template Library components such as containers and iterators for efficient data storage and manipulation.

Sr. No.	Text Books
1.	"Data Structures and Algorithms Made Easy" – Narasimha Karumanchi.
2.	"Data Structures Using C" – Reema Thareja.
3.	"Introduction to Algorithms" – Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein.
Sr. No.	**Reference Books**
1.	"Fundamentals of Data Structures in C" – Ellis Horowitz, Sartaj Sahni, Susan Anderson-Freed.
2.	"Data Structures and Algorithm Analysis in C" – Mark Allen Weiss.
3.	"Data Structures and Algorithms in C++" – Robert Lafore.
Sr. No.	**Web Resources**
1.	HackerRank – https://www.hackerrank.com
2.	LeetCode – https://leetcode.com
3.	GeeksforGeeks – https://www.geeksforgeeks.org
4.	Programiz – https://www.programiz.com
5.	W3Schools – https://www.w3schools.com

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Course Title: Do It Yourself (DIY)		
Course Code: CS254806		**Course Category: EL**
Teaching Scheme	**Examination Scheme**	
Practical's /Sessions: 02 Hours/Week	CA-I	15 Marks
Credit: 1	CA-II	15 Marks
Semester: IV	ESE	20 Marks

Course Prerequisite:
Basic knowledge of computer networks, operating systems, IP addressing, web technologies, and information security fundamentals. Familiarity with Linux commands and basic command-line tools will be helpful.

Course Description:
This course provides hands-on exposure to ethical hacking concepts, tools, and techniques used for identifying, analyzing, and reporting security vulnerabilities in systems and networks. It includes foot printing, scanning, enumeration, vulnerability assessment, password security testing, wireless security basics, web application testing, system hardening, and security reporting. The course emphasizes legal and authorized security testing practices.

Course Objective:

- To develop practical skills in ethical hacking methodology, vulnerability discovery, basic penetration testing, and responsible security assessment using standard tools and controlled laboratory activities.

Course Outcomes:

COs	**After completion of the course students will be able to:**	**Bloom's Level**
CO1	**Explain** the ethical hacking process, laboratory setup, legal scope, and basic reconnaissance techniques used in authorized security assessment.	Understand Level 2
CO2	**Perform** host discovery, port scanning, service enumeration, and vulnerability scanning using standard security tools in a controlled environment.	Apply Level 3
CO3	**Assess** password security, basic web application vulnerabilities, wireless security weaknesses, and system security issues in a legal laboratory setup.	Analyze Level 4
CO4	**Prepare** a structured ethical hacking report that documents scope, methodology, tools used, findings, risk levels, and remediation recommendations.	Create Level 6

CO-PO Mapping:

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	2	2	-	-	2	1	3	-	-	-	1	1	2
CO2	2	3	1	2	3	1	2	1	-	-	2	2	2
CO3	2	3	1	2	3	2	2	1	-	-	2	3	2
CO4	1	2	1	1	2	1	3	1	3	1	2	1	3

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Assessment	
CA-I (a) (15M)	Students will be assessed on their understanding of ethical hacking laboratory setup and authorized scope definition, along with their ability to perform footprinting, reconnaissance, host discovery, port scanning, and service and operating system enumeration in a controlled environment. The assessment will consider procedural correctness, appropriate use of tools, interpretation of results, and viva/oral performance based on the practical activities carried out.
CA-II (b) (15M)	Students will be assessed on their ability to perform vulnerability scanning, password security testing, basic web application security assessment, and wireless and system security review in an ethical and controlled laboratory environment. Assessment will also include evaluation of their skill in documenting findings through a structured security report, explaining observed vulnerabilities and countermeasures, and answering questions in viva/oral related to the practical work performed.

Sr. No.	List of Activities
1.	Study and identify the components of an ethical hacking lab setup, including attacker machine, target machine, virtual machines, network configuration, and legal scope definition.
2.	Perform foot printing and reconnaissance using public information gathering techniques such as WHOIS lookup, DNS lookup, and search-engine-based enumeration.
3.	Conduct host discovery and port scanning on a target system using standard network scanning tools.
4.	Perform service enumeration to identify open ports, running services, operating system details, and possible exposed resources.
5.	Carry out vulnerability scanning on a test machine or vulnerable lab environment and record the identified weaknesses.
6.	Demonstrate password security testing in a controlled lab using password auditing tools and analyze password strength and common weaknesses.
7.	Perform basic web application assessments such as identifying input validation issues, weak authentication, exposed directories, and common OWASP-related flaws in a legal lab environment.
8.	Study basic wireless security by identifying Wi-Fi security modes, weak configurations, and methods of securing wireless access points.
9.	Analyze system security by reviewing user accounts, permissions, unnecessary services, firewall status, and patch/update condition on a lab machine.
10.	Prepare a professional ethical hacking report containing scope, methodology, tools used, findings, risk level, screenshots, and remediation recommendations.

Sr. No.	Textbooks
1.	CEH Certified Ethical Hacker All-in-One Exam Guide – Matt Walker
2.	Penetration Testing: A Hands-On Introduction to Hacking – Georgia Weidman
3.	Ethical Hacking and Penetration Testing Guide – Rafay Baloch
4.	The Basics of Hacking and Penetration Testing – Patrick Engebretson
5.	Network Security Assessment – Chris McNab
	Reference Books
1.	The Web Application Hacker's Handbook – Dafydd Stuttard and Marcus Pinto
2.	Hacking: The Art of Exploitation – Jon Erickson
3.	Network Security Essentials – William Stallings
4.	Metasploit: The Penetration Tester's Guide – David Kennedy, Jim O'Gorman, Devon Kearns, Mati Aharon
5.	Practical Malware Analysis – Michael Sikorski and Andrew Honig
	Web Resources
1.	https://owasp.org/
2.	https://nvd.nist.gov/
3.	https://www.cisa.gov/
4.	https://www.kali.org/docs/
5.	https://docs.rapid7.com/metasploit/

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Course Title: Computational Statistics for AI **Course Code: CS254401**	**Course Category: MDM-II**	
Teaching Scheme	**Examination Scheme**	
Lectures: 02 hrs. / week	CA-1	10 Marks
Tutorial: -	CA-2	10 Marks
Credits: 02	MSE	20 Marks
Semester: Second Year (Semester IV)	ESE	60 Marks

Course Prerequisite:

- **Mathematical Foundations:** elementary mathematics, algebra, and functions, logical reasoning, mean, median, mode, probability basics.
- **Basics of Python:** Basic computer skills, basic programming tools.

Course Description:

This course introduces fundamental concepts of statistics and probability for data analysis and artificial intelligence applications. It covers data types, descriptive statistics, and visualization techniques to summarize and interpret real-world datasets. The course develops a strong foundation in probability theory, random variables, and probability distributions for modeling uncertainty. It further explores statistical modeling techniques, including correlation and regression, for analyzing relationships between variables. The course also focuses on inferential statistics and hypothesis testing to support data-driven decision making in practical scenarios.

Course Objectives:

1. **To introduce** fundamental concepts of statistics, data types, and data visualization for effective data understanding and analysis**.**
2. **To develop** a strong foundation in probability theory, including conditional probability and Bayes' theorem, for modeling uncertainty in data science applications.
3. **To understand** probability distributions and statistical modeling techniques, including regression and correlation, for analyzing real-world datasets.
4. **To apply** inferential statistical methods such as hypothesis testing and confidence intervals for data-driven decision making and evaluation of models.

Course Outcomes:		
COs	**After completion of the course students will be able to**	**Bloom's Level**
CO1	**Recall** fundamental concepts of statistics, probability theory, probability distributions, statistical modeling, and hypothesis testing.	Remember (Level 1)
CO2	**Explain** data types, descriptive statistics, probability laws, distributions, regression models, and hypothesis testing procedures used in data analysis.	Understand (Level 2)
CO3	**Interpret** statistical measures, probability concepts, distributions, regression techniques, and hypothesis testing methods to analyze real-world datasets and solve data-driven problems.	Apply (Level 3)
CO4	**Examine** data using statistical and probabilistic models, evaluate relationships between variables, and interpret hypothesis testing results for informed decision making.	Analyze (Level 4)

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CO-PO-PSO Mapping													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	1	–	–	–	–	–	–	–	–	2	1	1
CO2	3	2	1	1	–	–	–	–	–	–	2	2	1
CO3	3	3	2	2	2	–	–	–	–	–	2	3	2
CO4	3	3	2	3	2	1	–	–	–	–	3	3	2

Assessment	
CA-1 (a)	Subjective Test / Assignment/ MCQ Test etc.
CA-2 (b)	Subjective Test / Assignment/ MCQ Test etc.
MSE (c)	Subjective Test

Course Contents		
Unit 1	**Introduction to Statistics** About statistics, population vs sample, types of statistical data- categorical, numerical (continuous), ordinal, interval, ratio, univariate and bivariate analysis, Measures of central tendency: mean, median, mode, harmonic mean, Measures of dispersion - variance, standard deviation and coefficient of variation, outliers, data visualization- line graph, scatter, box plots, histogram. Case Study on real estate company dataset to measures of central tendency and dispersion.	4 Hrs.
Unit 2	**Probability Theory** Introduction to probability and its role in data science, Basics of probability- random experiments, sample Space, events, axioms of probability, addition and multiplication laws of probability, Conditional probability and independence, Bayes' theorem, discrete vs continuous random variables. Case Study on Customer Conversion Analysis for e-commerce site using Bayes' theorem.	4 Hrs.
Unit 3	**Data Modeling using Distributions** Introduction to inferential statistics, what is distribution, concept of probability distributions, expectation(mean) and variance, Skewness and interpretations, kurtosis, Central limit theorem. Case study on distribution analysis and sampling behavior interpretation using real estate company dataset.	4 Hrs.
Unit 4	**Theoretical Distributions** Discrete distributions– Bernoulli distribution, Binomial distribution and Poisson distribution, Uniform distribution, Normal distribution. Case study on modeling the customer arrivals using appropriate distributions and its visualization.	4 Hrs.
Unit 5	**Statistical Modeling** Covariance and correlation, interpretation of correlation, Correlation coefficient, simple linear regression, multiple linear regression, concept of overfitting, model	4 Hrs.

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	assumptions, estimation of regression coefficients, Error metrics– Mean Square Error. Case study on real-world housing dataset to analyze the relationship between property features.	
Unit 6	**Hypothesis Testing and Statistical Tests** Typical analysis procedures, introduction to inferential statistics, point estimation, confidence intervals, hypothesis testing concept, Null and Alternative hypotheses, Type I and Type II errors, Rejection region, level of significance, p-value, one-tailed and two-tailed tests, Tests on numerical data– distribution of sample mean, Comparison of two groups– Z-test. Case study on hypothesis testing in data-driven decision making.	4 Hrs.

Sr. No.	**Textbooks**
1.	Joel Grus, Data Science from Scratch, O'Reilly Media, ISBN- 9781491901427
2.	S. C. Gupta, Fundamentals of Statistics, Himalaya Publishing House, 7th Revied and Enlarged Edition, 2016.
Sr. No.	**Reference Books**
1.	Peter Bruce and Andrew Bruce, Practical Statistics for Data Scientists, First Edition, O'Reilly Media, ISBN- 978-1-491-95296-2.
2.	Claus Weihs, Olaf Mersmann, Uwe Ligges, Foundations of Statistical Algorithms, CRC Press, ISBN- 978-1-4398-7887-3.
3.	Kishor S. Trivedi, Probability, Statistics with Reliability, Queuing and Computer Science Applications, Wiley India Pvt. Ltd, 2nd Edition, 2001.
4.	Vijay K. Rohatgi, A. K. Md. Ehsanes Saleh, An Introduction to Probability and Statistics, Wiley. Third Edition, ISBN:9781118799642
Sr. No.	**Web Resources**
1.	**NPTEL course: Statistics for Data Science, IITM:** https://study.iitm.ac.in/ds/course_pages/BSMA1002.html
2.	**NPTEL course: Statistical Methods for Scientists and Engineers, IITKGP:** https://nptel.ac.in/courses/111/105/111105077/#
3.	**NPTEL course: Essential Mathematics for Machine Learning, IIT Roorkee**: https://nptel.ac.in/courses/111/107/111107137/#
4.	**Coursera -Probability & Statistics for Machine Learning & Data Science** https://www.coursera.org/learn/machine-learning-probability-and-statistics

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Course Title: Dataware Housing and Data Mining **Course Code: CS254212**		**Course Category: HMM-II**
Teaching Scheme	**Examination Scheme**	
Lectures: 04 hrs. / week	CA-1	10 Marks
Tutorial: -	CA-2	10 Marks
Credits: 04	MSE	20 Marks
Semester: Second Year (Semester IV)	ESE	60 Marks

Course Prerequisite:

- Understanding of Data Structures and Algorithms
- Fundamentals of Data, Patterns

Course Description:

This course introduces the concepts of data warehousing and data mining for knowledge discovery and decision support systems. It covers data warehouse architecture, data preprocessing, association rules, classification, prediction, and clustering techniques. The course also explores advanced mining applications such as web, text, spatial, and multimedia data mining and provides exposure to tools like WEKA, KNIME, and Apache Hadoop for practical data analysis.

Course Objectives:

1. To introduce the fundamental concepts of data warehousing, architecture, and decision support systems.
2. To understand data preprocessing techniques such as data cleaning, integration, transformation, and reduction.
3. To study and apply data mining techniques including association rule mining, classification, and prediction methods.
4. To analyze clustering techniques and cluster analysis methods for discovering patterns in large datasets.
5. To explore advanced data mining applications and tools for mining spatial, text, multimedia, and web data.

Course Outcomes:		
COs	**After completion of the course students will be able to**	**Bloom's Level**
CO1	**Understand** fundamental concepts of data warehousing, OLAP/OLTP, data mining functionalities, and system architectures.	Understand (Level 2)
CO2	**Explain** the processes of data preprocessing, data cleaning, integration, transformation, and data warehousing architecture.	Understand (Level 2)
CO3	**Apply** classification (Decision Tree, Naïve Bayes, KNN) and clustering (K-Means, PAM) techniques to solve real-world data mining problems.	Apply (Level 3)
CO4	**Analyze** the performance of association rule mining, classification, and clustering techniques, and interpret results using tools such as WEKA, KNIME, RapidMiner, Orange, and Apache Mahout for various data types	Analyze (Level 4)

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CO-PO-PSO Mapping

CO-PO-PSO Mapping													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	2	1			-	-	-	-	-	-	2	1
CO2	3	2	2			-	-	-	-	-	-	2	1
CO3	3	3	2	2	3	-	-	-				3	2
CO4	3	3			3		-	-				3	2

Assessment	
CA-1 (a)	Subjective Test / Assignment/ MCQ Test etc.
CA-2 (b)	Case Study / Assignment/ MCQ Test etc.
MSE (c)	Subjective Test

Course Contents		
Unit 1	**Introduction to Data Warehousing** Data Warehousing and Business Analysis: - Data warehousing Components, Building a Data warehouse –Data Warehouse Architecture, DBMS Schemas for Decision Support, Data Extraction, Cleanup, and Transformation Tools Metadata, reporting, Query tools and Applications, OLAP and OLTP	8 Hrs.
Unit 2	**Data Mining:** Data Mining Functionalities, Data Preprocessing, Data Cleaning, Data Integration and Transformation, Data Reduction, Data Discretization and Concept Hierarchy Generation, Architecture Of A Typical Data Mining Systems, Association Rule Mining: Efficient and Scalable Frequent Item set Mining Methods, Mining Various Kinds of Association Rules , Association Mining to Correlation Analysis, Constraint-Based Association Mining.	8 Hrs.
Unit 3	**Classification** Problem Definition, General Approaches to solving a classification problem, Evaluation of Classifiers, Classification techniques, Decision Trees-Decision tree Construction, Algorithm for Decision tree Induction. Naive-Bayes Classifier, Bayesian Belief Networks; K- Nearest neighbour classification-Algorithm and Characteristics. Prediction: Accuracy and Error measures, Evaluating the accuracy of classifier or a predictor	8 Hrs.
Unit 4	**Cluster Analysis** Types of Data in Cluster Analysis A Categorization of Major Clustering Methods, Partitioning Methods,Partitioning Clustering-K-Means Algorithm, PAM Algorithm, Hierarchical methods, Density-Based Methods, Grid-Based Methods, Model-Based Clustering Methods, Clustering High-Dimensional Data, Constraint-Based Cluster Analysis, Outlier Analysis.	8 Hrs.

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Unit 5	**Advanced data mining application** Mining Object, Spatial, Multimedia, Text and Web Data: Multidimensional Analysis and Descriptive Mining of Complex Data Objects, Spatial Data Mining, Multimedia Data Mining, Text Mining, Mining the World Wide Web.	8 Hrs.
Unit 6	**Study of data warehousing and data mining tools** Dataware housing Tools- Apache Hive, PostgreSQL, Apache Hadoop Data mining Tools- WEKA-Free open-source software, KNIME-Open source analytics platform, RapidMiner, Orange Data Mining-Visual programming tool for data analysis and visualization, Apache Mahout Open-source framework for large-scale machine learning and data mining algorithms.	8 Hrs.

Sr. No.	Textbooks
1.	Jiawei Han, Micheline Kamber, Jian Pei , Data Mining: Concepts and Techniques,Morgan Kaufmann / Elsevier Edition: 3rd Edition
2.	Sam Anahory, Dennis Murray , Data Warehousing in the Real World, Addison-Wesley
Sr. No.	**Reference Books**
1.	Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer
2.	Ralph Kimball, Margy Ross, The Data Warehouse Toolkit, Wiley
3.	David Hand, Heikki Mannila, Padhraic Smyth, Principles of Data Mining, MIT Press
4.	Tom M. Mitchell,Machine Learning, McGraw-Hill
Sr. No.	**Web Resources**
1.	NPTEL Data Mining
2.	Coursera Data Mining Specialization
3.	Coursera Data Warehousing Course

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Course Title: ADVANCED DATABASE MANAGEMENT SYSTEMS **Course Code: CS254212** **Course Category: DM-II (Track-I)**		
Teaching Scheme	**Examination Scheme**	
Lectures: 04 hrs. / week	CA-1	10 Marks
Tutorial: –	CA-2	10 Marks
Credits: 04	MSE	20 Marks
Semester: Second Year (Semester IV)	ESE	60 Marks

Course Prerequisite: Fundamentals of Database Management Systems (DBMS)
Basic knowledge of SQL and relational algebra
Understanding of data structures and algorithms
Basic concepts of operating systems and file systems

Course Description: This course provides an in-depth understanding of advanced database concepts including data mining, data warehousing, query processing and optimization techniques. It covers modern database paradigms such as object-oriented, temporal, spatial, and multimedia databases. The course also explores database security, administration, and emerging technologies such as distributed databases.

Course Objectives:

1. To provide knowledge of data mining techniques and data warehousing concepts along with OLAP operations and tools.
2. To develop the ability to understand and apply query processing and optimization techniques for efficient database performance.
3. To introduce advanced database models : object-oriented, temporal, spatial, and multimedia databases.
4. To impart knowledge of database security, administration, and auditing practices.

Course Outcomes		
COs	**After completion of the course students will be able to**	**Bloom's Level**
CO1	**Understand** concepts of data mining, data warehousing, OLAP	Understand (Level 2)
CO2	**Apply** query processing and optimization techniques for efficient database operations.	Apply (Level 3
CO3	**Apply** concepts of object-oriented, temporal, spatial and multimedia databases in real-world applications.	Apply (Level 3)
CO4	**Analyze** database security, administration and modern distributed database systems.	Analyze (Level 4)

CO-PO-PSO Mapping

CO-PO-PSO Mapping													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	2	-	-	-	-	-	-	-	-	2	2	3
CO2	3	3	2	-	3	-	-	-	-	-	2	2	3
CO3	3	2	3	-	-	2	-	-	-	-	2	3	3
CO4	3	3	2	-	-	3	-	-	-	-	2	3	3

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Assessment	
CA-1 (a)	Subjective Test / Assignment/ MCQ Test etc.
CA-2 (b)	Case Study / Assignment/ MCQ Test etc.
MSE (c)	Subjective Test

Course Contents		
Unit 1	**Data Mining and Data Warehousing** Classification, Clustering, Association rule mining, Multimedia data mining, Web Mining, Data Warehouse Architecture, Schema Design (star vs snowflake), Schema Evolution, Incremental and Batch updates, Extract-Transform-Load (ETL), Data Cube and Online Analytical Processing (OLAP), ROLAP and MOLAP, Tools : Informatica and Cognos	8 Hrs.
Unit 2	**Query Execution and Optimization** Architecture of Query Execution Engines, Disk Access, Measures of Query Cost, Introduction to Physical-Query-Plan Operators, One-Pass Algorithms for Database Operations, Nested-Loop Joins, Two-Pass Algorithms Based on Sorting, Two-Pass Algorithms Based on Hashing, IndexBased Algorithms, Algorithms Using More Than Two Passes. Query Optimization, SQL Query Writing vs. SQL Query processing, Reducing Complexity, Writing Efficient Queries	8 Hrs.
Unit 3	**Object Oriented, Temporal and Spatial Databases** Object Identity, Object structure, Type Constructors, Encapsulation of Operations, Methods, Persistence, Type and Class Hierarchies, Inheritance, Complex Objects, Object-oriented DBMS, Languages and Design: ODMG Model, Object Definition Languages (ODL), Object Query Languages (OQL) Time Ontology, Structure, and Granularity, Temporal Data Models, Temporal Relational algebras.	8 Hrs.
Unit 4	**Introduction to Spatial Database** Types of Spatial Data, Geographical Information Systems (GIS), Conceptual Data Models for Spatial Databases, Logical data models for spatial databases: raster and vector model, Physical data models for spatial databases, Clustering methods	8 Hrs.
Unit 5	**Multimedia Databases** Fundamentals of Multimedia Database System, Data Access, Multimedia Information Modelling and Querying, Multimedia Database, Multimedia Communication, Multimedia Storage and Retrieval, Multimedia Programming	8 Hrs.
Unit 6	**Data Administration, Security and recent trends** Security issues faced by enterprises, Security architecture, Operating system security principles, Administration of users, Profiles, password policies, privileges and roles, Database application security models, Database auditing models, Database integrity Auditing, Application data auditing, Practices of database auditing Database-as-a-Service (DBaaS), Hybrid and Multi-cloud Database Architectures, Dynamo a structured storage system, Hadoop Distributed File System, MapReduce framework, HIVE	8 Hrs.

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Sr. No.	Textbooks
1.	Hector Garcia-Molina, Jeffrey D. Ullman and Jennifer Widom, “Database System:The Complete Book”, Pearson, 2nd edition (2008), ISBN-10: 0131873253, ISBN-13: 978- 0131873254
2.	Raghu Ramakrishnan and Johannes Gehrke, “Database Management Systems”, McGraw Hill Education, 3rd edition (2014), ISBN-10: 9339213114, ISBN-13: 978-9339213114
3.	Guojun Lu,”Multimedia Database Management Systems”, Artech House.
4.	Shashi shekhar, Sanjay chawla, “Spatial database”, Pearson education
Sr. No.	**Reference Books**
1.	Jiawei Han, Micheline Kamber, and Jian Pei, “Data Mining Concepts and Techniques”, 3 rd Edition, Morgan Kaufmann, ISBN: 978-93-80931-91-3
2.	Korth, Silberschatz and Sudarshan, “Database System Concepts”, Tata McGraw Hill, 6th edition (2013), ISBN-10: 9332901384, ISBN-13: 978-9332901384
3.	P. Selinger, M. Astrahan, D. Chamberlin, Raymond Lorie and T. Price, “Access Path Selection in a Relational Database Management System”, Proceedings of ACM SIGMOD, pp 23-34, 1979
Sr. No.	**Web Resources**
1.	Data Mining Tutorial – Great Learning
2.	What is OLAP – Tutorialspoint Article
3.	NPTEL Data Mining for Decision Making
4.	Stanford Databases Course (edX)

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Course Title: Server-Side Technologies and Frameworks **Course Code: CS254114** **Course Category: DM-II (Track 2)**		
Teaching Scheme	**Examination Scheme**	
Lectures: 04 hrs. / week	CA-1	10 Marks
Tutorial: -	CA-2	10 Marks
Credits: 04	MSE	20 Marks
Semester: Second Year (Semester IV)	ESE	60 Marks

Course Prerequisite:

- Knowledge of client-side technologies and frameworks.

Course Description:

This course introduces server-side web technologies, covering web architecture, HTTP protocols, and application server concepts. It focuses on Java-based technologies such as Servlets and JSP for dynamic web development, along with web services using REST and SOAP. The course also explores modern server-side development using Node.js and Express.js, emphasizing security, API design, and scalable web application development.

Course Objectives:

The objective of this course is to provide the students:

1. Knowledge of server-side programming fundamentals.
2. Configuration of servers and use of Web services.
3. Understanding of Java Servlets and JSP for server-side development.
4. Utilization of Node.js with Express.js in server-side applications.

Course Outcomes:		
COs	**After completion of the course: Students should be able to**	**Bloom's Level**
CO1	**Explain** the fundamental concepts and architectural patterns in server-side programming.	Understand
CO2	**Configure** application servers for hosting web applications.	Evaluate
CO3	**Use** Java Servlet and JSP for server-side programming.	Apply
CO4	**Select** appropriate web services for web applications.	Understand
CO5	**Demonstrate** the use of Node.js with Express.js in server-side applications.	Apply

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	-	-	1	1
CO2	1	2	1	-	3	-	-	-	-	-	2	1	1
CO3	1	1	2	-	1	-	-	-	-	-	2	1	1
CO4	1	2	2	-	2	-	-	-	-	-	2	1	1
CO5	1	2	3	-	3	-	-	-	-	-	2	1	1

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Assessment	
CA-1 (a)	Subjective Test / Assignment/ MCQ Test etc.
CA-2 (b)	Subjective Test / Assignment/ MCQ Test etc.
MSE (c)	Subjective Test

Course Contents		
Unit 1	**Fundamentals of Server-Side Technologies** Introduction to web architecture, client-server architecture model and communication, Request/Response cycle, HTTP and HTTPS protocols, HTTP methods- GET, PUT, POST, DELETE, status codes, APIs, MVC and MVVM architectural patterns in frameworks. Security Fundamentals: Input validation and sanitization, Cross-site scripting (XSS), SQL injection, Authentication (sessions, cookies, JWT), overview of HTTPS and SSL/TLS, best practices for securing server applications.	8 Hrs.
Unit 2	**Web and Application Servers** Introduction to Application Servers, Difference between Web Server and Application Server, Middleware concept, Business logic layer, Popular Application servers- Apache Tomcat, JBoss, Glassfish, microservices deployment overview, Server Configuration & Management: Virtual Hosting, Name-based virtual hosting, IP-based hosting, multi-site configuration, security configuration, SSL/TLS setup, HTTPS configuration.	8 Hrs.
Unit 3	**Java Servlets** Servlet architecture overview, Servlet life cycle, setting up Servlet development environment, request and response handling in Servlets, Servlets generating dynamic content, parameter data, sessions tracking methods in Servlets and session management, Servlets concurrency, Servlet and database connectivity.	8 Hrs.
Unit 4	**Java Server Pages** Java Server Pages life cycle, support for the Model-View-Controller paradigm, JSP vs Servlets, running JSP applications, JSP tags, JSP action tags, JSP implicit objects, JSP and database connectivity, JavaBeans classes and JSP, JSTL (Java Server Pages Standard Tag Library) and Expression Language (EL).	8 Hrs.
Unit 5	**Web Services** Need for web services, data exchange using JSON, SOAP vs. RESTful web services, RESTful principles (Statelessness, Resource-based architecture), overview of request handling in RESTful API, URI design, Status codes. SOAP web services: Simple Object Access Protocol (SOAP), XML-based messaging, WSDL (Web Services Description Language), UDDI. Case Study: Configuration of Apache-tomcat application server and simple web-application.	8 Hrs.
Unit 6	**Server-side Rendering: Node.js with Express.js** Node.js: Introduction to Node.js runtime environment, setting up the development environment for Node.js, event-driven and non-blocking I/O model, Node.js architecture: single-threaded event loop, node modules, npm packages, package.json and semantic versioning, core modules, simple HTTP server with Node.js core http module. Express.js: Introduction to the Express.js framework, setting up an Express application, use of Express middleware, Express routing, serving static files with Express, and REST API with Express.js.	8 Hrs.

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CSE Engg.

	Case study: Lenskart web application based on Node.js and Express.js.	

Sr. No.	Textbooks
1.	M. Hall, L. Brown, and Y. Chaikin, Core Servlets and JavaServer Pages, Volume II: Advanced Technologies, 2nd ed. Upper Saddle River, NJ, USA: Pearson Education, 2007. ISBN-13: 9780130092298.
2.	Jeffrey C. Jackson, Web Technologies: A Computer Science Perspective, 2007, Second Edition, Pearson Education, ISBN 978-0131856035.
3.	B. Kurniawan and P. Deck, Servlet, JSP and Spring MVC, San Francisco, CA, USA: Brainy Software Inc., 2015. ISBN-13: 9781771970273.
4.	R. W. Sebesta, Programming the World Wide Web, 4th ed. Boston, MA, USA: Pearson Education, 2008.
5.	A. Mead, Learning Node.js Development. Birmingham, U.K.: Packt Publishing, 2018. ISBN: 978178839554
Sr. No.	**Reference Books**
1.	Marty Hall, Larry Brown, Core Web Programming, 2001, Second Edition, Pearson Education, ISBN- 978-0130897930.
2.	Ethan Brown, Web Development with Node and Express", 2019, Second Edition, O'Reilly Publication, ISBN-10:1492053511, ISBN-13:978-1492053514
3.	H.M. Deitel, P.J. Deitel and A.B. Goldberg, "Internet & World Wide Web How To Program", Third Edition, Pearson Education, 2006, ISBN 978-0131752429.
4.	Chris Bates, "Web Programming Building Internet Applications", 3rd Edition, Wiley India, 2006
Sr. No.	**Web Resources**
1.	NPTEL course: Web Technology by Dr. Ashutosh Kumar Bhatt, Uttarakhand Open University, Haldwani. https://onlinecourses.swayam2.ac.in/nou25_cs23/preview
2.	NPTEL course: Modern Application Development by Prof. Aamod Sane, Prof. Abhijat Vichare, Prof. Madhavan Mukund, Persistent Computing Institute. https://onlineco urses.nptel.ac.in/noc20_cs52/preview