CURRICULUM STRUCTURE

SECOND YEAR UG: B.TECH

COMPUTER SCIENCE AND ENGINEERING

REVISION: FRCRCE-3-26

Effective from Academic Year 2026-27
Board of Studies Approval: 4/3/2026
Academic Council Approval: 27/3/2026

Dr. DEEPAK BHOIR	Dr. JAGRUTI SAVE	DR. SAPNA PRABHU
Dean Academics	HOD (CSE)	Principal

Institute Vision

To be a leading institution in education, transforming students into globally competent professionals with strong ethical values, innovation capabilities, and a commitment to sustainable societal development.

Institute Mission

- Develop industry-ready engineers with strong academic foundations, practical skills, and an entrepreneurial mindset capable of addressing industry and societal needs.
- Cultivate a culture of innovation and research to address real-world challenges through interdisciplinary approaches and sustainable practices.
- Foster a vibrant industry–academia ecosystem by actively engaging faculty and students in knowledge exchange, collaborative learning and professional skill development.

Department Vision

To achieve excellence in Computer Science education by nurturing technically competent and socially responsible professionals who solve real-world problems.

Department Mission

1. Facilitate an excellent scholastic environment for students and faculty to promote research, innovation and interdisciplinary learning.
2. Foster a culture of experiential learning and sustainable practices through projects, internships and industry engagement.
3. Promote participation in co-curricular and extra-curricular activities to build integrity, communication, teamwork and leadership.

Program Educational Objectives (PEO)

Graduates will be able to

1. Design, develop and implement innovative computing solutions that promote sustainable development and socio-economic growth.
2. Pursue lifelong learning and advanced education by adapting to evolving technologies and diverse career opportunities.
3. Exhibit ethical conduct, leadership, and effective interpersonal skills in their professional domain.

Program Specific Outcomes (PSO)

Students will be able to

1. Apply computational thinking, algorithmic design and software development principles to build efficient computing solutions.

2. Develop scalable and intelligent computing solutions using emerging technologies such as Artificial Intelligence, Data Science and Distributed Systems to solve complex problems.

Preamble:

Fr Conceicao Rodrigues College of Engineering (Fr. CRCE) is an Autonomous Institute from the year 2024-25. The University Grant Commission vide letter No. F. 2-10/2023(AC-Policy) dated 23rd Nov 2023 conferred the autonomous status to Fr. Conceicao Rodrigues College of Engineering, Fr. Agnel Ashram, Bandstand, Bandra (West), Mumbai 400050 affiliated to the University of Mumbai for a period of 10 years from the Academic year 2024-2025 to 2033-2034 as per clause 7.5 of the UGC (Conferment of Autonomous Status Upon Colleges and Measures for Maintenance of Standards in Autonomous Colleges) Regulations, 2023. We look towards Autonomy as a great opportunity to design and implement a curriculum sensitive to the needs of Learners, Indian Society, and Industries. We are committed to the effective implementation of the UGC Regulations and NEP 2020 in its spirit. The Government of Maharashtra has directed Autonomous Colleges to revise their curriculum in line with the National Education Policy (NEP) 2020 through a Government Resolution dated 4th July 2023. Accordingly, degree options are given to the students admitted from the academic year 2024-25 based on the UGC circulars and the DTE guidelines ref no. 17/DTE/NEP-2020/2024/111 dated 4th June 2024 related to the implementation of NEP.

Based on the recent recommendations of the GR, we are pleased to offer our holistic curriculum, a "H-Tree Model" of Engineering Education. A unique "H-Tree Model" of Engineering Education Curriculum is carefully designed to systematically develop IQ (Intelligence Quotient), PQ (Physical Quotient), EQ (Emotional Quotient) and SQ (Spiritual Quotient) of a learner. This curriculum aims at the development of a well-rounded personality through a holistic approach to education in which the learner receives 25% teacher-led learning, 25% peer learning, 25% self-learning and 25% experiential learning. The curriculum model is outcome-based that focuses on learning by doing. The curriculum is designed to provide multiple learning opportunities for students to acquire and demonstrate competencies for rewarding careers. It offers curated, interest-driven pathways that empower learners to acquire skills through structured, strategic planning. It has 7 verticals aligned to the GR recommendations with a strong science and mathematics foundation and Program core, Sequence of electives, Multidisciplinary Minor courses, Humanities & Management courses along with sufficient experiential learning through projects and a semester-long industry / research internship along with employable skill-based courses. Learners get an opportunity to acquire skills through NSDC-aligned courses during the summer vacations. Additionally, learners can choose from multiple degree pathways, including a built-in Multidisciplinary Minor, a Double Minor in emerging fields, or Honors with Research.

The curriculum integrates emerging industry trends with skill-based learning to foster innovation and analytical problem-solving. It offers flexible, multidisciplinary course choices with a strong emphasis on experiential and project-based learning. The Program Core Courses comprehensively cover the fundamental and advanced areas of Computer Science and Engineering, including Data Structures and Algorithms, Artificial Intelligence, Machine Learning, Data Science, Cybersecurity, Software Engineering, Computer Networks, Operating Systems, and other department-specific specializations.

Various steps are taken to transform the teaching-learning process to make learning a joyful experience for students. We believe that this curriculum will raise the bar of academic standards with the active involvement and cooperation from students, academic and administrative units.

Curriculum Structure for UG Programs at Fr CRCE w.e.f. A.Y. 2026-27

Nomenclature of the courses in the curriculum	
Abbreviation	**Title**
BSESC	Basic Science & Engineering Science Courses
PCPEC	Program Core and Program Elective Courses
MDC	Multidisciplinary Courses
SC	Skill Courses
HSSM	Humanities, Social Sciences and Management
EL	Experiential Learning
LLC	Liberal Learning Courses
BSC	Basic Science Courses
ESC	Engineering Science Courses
PCC	Program Core Courses
PEC	Program Elective Courses
MDM	Multidisciplinary Minor
OE	Open Elective
VSEC	Vocational and Skill Enhancement Course
VSC	Vocational Skill Courses
SEC	Skill Enhancement Courses
AEC	Ability Enhancement Course
EEMC	Entrepreneurship, Economics and Management Course
IKS	Indian Knowledge System
VEC	Value Education
RM	Research Methodologies
CEFP	Community Engagement or Field Project
ELC	Experiential Learning Courses
PRJ	Project
INT	Internship
CC	Cocurricular Courses
HMM	Honors and Multidisciplinary Minor
DM	Double Minor
HR	Honors with Research

Credit Specification:

- Theory: 1 credit=13 to 15 hrs of teaching
- Lab: 1 Credit=26 to 30 hrs of lab work
- Studio Activities: 1 Credit= 26 to 30 hrs of creative activities
- Workshop Based Activities: 1 Credit=26 to 30 hrs of hands-on activities related to vocation/professional practice/skill based
- Seminar/Group Discussion: 1 Credit=13 to 15 hrs of participation
- Internship: 1 Credit=Per 2 weeks OR 36 to 40 hrs of engagement
- Field Based Learning/Practices: 1 Credit=26 to 30 hrs of learning activities
- Community Engagement Projects: 1 Credit=26 to 30 hrs of contact time along with 13 to 15 hrs of activities preparation, report writing, independent reading etc.

Credit requirements for four different options of the Degrees:

Degree/SEM	I	II	III	IV	V	VI	VII	VIII	Total
B.Tech (Multidisciplinary Minor)	20	20	22	22	22	22	20	20	168
B.Tech with Double Minor (Multidisciplinary & Specialization Minor)	20	20	22+4*	22+4*	22+4*	22+4*	20+2$	20	186
B.Tech with Honors with Research (Multidisciplinary Minor)	20	20	22+4*	22+4*	22+4*	22+4*	20+2$	20	186

*Optional Credits
$ optional 2 credits can be earned either in VII or VIII Semester

1. Learners who earn a minimum of total 168 credits will be awarded "B.Tech in Engg. /Tech. with Multidisciplinary Minor (MDM)" degree.
2. Learners will have the following options to earn B. Tech. in Engg. /Tech. degree in
    a. Major Engg./Tech Discipline with Double Minor (Multidisciplinary and Specialization Minor)
    b. Major Engg./Tech Discipline with Honors with Research and Multidisciplinary Minor
3. Major Engg./Tech Discipline with Double Minor (Multidisciplinary and Specialization Minor) (additional 18 credits): 168 +18 =186 Min Credits. There will be four courses (4 credits each), one in each semester starting from the III semester which will be from emerging areas of specialisation. In VII or VIII semester students will complete 2 credits seminar/project. Admission eligibility min CGPA=7.5 after First year
4. B.Tech in Engg./ Tech.- Honors with Research and Multidisciplinary Minor (additional 20 credits by research): 168 +18=186 Min Credits. (Admission eligibility: min CGPA=7.5 after First and should maintain CGPA=7.5 after Third year)
5. Learner can earn the certificate/Diploma/Degree based on his/her exit from the program as follows. College shall explore feasibility to offer NSDC aligned skill-based courses to the learners:
    a. UG Certificate: After a one-year (40 credits to be earned) and 8-credits summer workshop/vocational courses/internship
    b. UG Diploma: After two-years (80 credits to be earned) and 8-credits summer workshop/vocational courses/internship/Project
    c. B.Voc.: After three-years (120 credits to be earned) and 8-credits summer workshop/vocational courses/internship/Project

Salient Features of Curriculum:

- Framed as per Government Resolution dated 4th July 2023 in line with National Education Policy (NEP) 2020.
- Minimum 168 choice-based credit structure with options of Degrees earning additional credits
- Unique 'H-Tree' Model of Curriculum: Hybrid model for holistic development with happy learning environment having bridge connecting verticals providing unique path for each learner for 3-dimensional growth, Life Long Learning, multiple entry-exit, inclusive model indicating equal distribution of central resources
- More emphasis on laboratory based and experiential learning
- More weightage to continuous assessment to reduce examination stress
- Mandatory Semester-long internship, courses with emotional & spiritual learning and skill-based learning aligned with NSDC framework
- Well balanced curriculum to attain Program Outcomes and skills of 21st century learner

	Course Verticals																	Total Credits
	BSESC		PCPEC		MDC		SC	HSSM				EL				LLC	BC	
SEM	BSC	ESC	PCC	PEC	MDM	OE	VSEC	AEC	EEMC	IKS	VEC	RM	CEFP	PRJ	INT	CC	BC	
I	6	11					1									2	--	20
II	6		5				1	4		2						2	--	20
III	3		11		3	2					2		1					22
IV	3		11		3	2	2				1						2*	22
V			12	3	3	2	2											22
VI			13	4	3	2												22
VII & VIII				15	3							4		6	12		--	40
Total Credits as per Fr CRCE	18	11	52	22	15	8	6	4		2	3	4	1	6	12	4	2*	168
Total Credits as per GR	14	12	44	20	14	8	8	4	4	2	4	4	2	4	12	4		160

- Bridge course is only for second year direct admission students.

Society of St. Francis Xavier, Pilar's
Fr. Conceicao Rodrigues College of Engineering
Fr. Agnel Ashram, Bandstand, Bandra (W), Mumbai – 400 050
(Autonomous College affiliated to University of Mumbai)

Curriculum Structure for UG Programs at Fr CRCE
Second Year Computer Science and Engineering Program

SEM-III												
Course Code	Course Vertical	Sub-Vertical	Course Name		Contact Hours	Examination Marks (1 Credit=50 Marks)					Credits	
						ISE	MSE	ESE		Total	Points	Total
								Min	Max			
25BSC12CS05	BSESC	BSC	Discrete Maths and Statistics	TH	2	20	30	20	50	100	2	2
				SL	2							
25PCC12CS09	PCPEC	PCC	Database Management System	TH	2	20	30	20	50	100	2	3
				PR	2	50	-	-	-	50	1	
				SL	2							
25PCC12CS06	PCPEC	PCC	Data Structures	TH	2	20	30	20	50	100	2	4
				PR	2	50	-	-	-	50	1	
				TU	1	50	-	-	-	50	1	
				SL	3							
25PCC12CS07	PCPEC	PCC	Object Oriented Programming with JAVA	PR	2	50	-	-		50	1	1
25OE12CS1X	MDC	OE	1. Law for Engineers 2. Financial Planning, Taxation and Investment	TH	2	100	-	-		100	2	2
				SL	2							
25MDMXX1	MDC	MDM	MDM Course-1	TH	2	20	30	20	50	100	2	2
				SL	2							
25MDMXX2	MDC	MDM	MDM Course-2	TH	2	20	30	20	50	100	2	2
				SL	2							
25AEC12CS02X	HSSM	AEC	Modern Indian Language	TH	2	100	--	--		100	2	2
				SL	2							
25VEC12CS01	HSSM	VEC	Human Values and Professional Ethics	TH	1	100	-	-		100	1	2
				PR	2						1	
				SL	1							
25CEP12CS01	EL	CEFP	Community Engagement Project	PRJ	4	100	-	-		100	2	2
25DMX1	DM	DM	Double Minor Course-1	TH	2	20	30	20	50	100	2	4*
				TU	2	20	-	-		50	2	
25HR01	HR	HR	Honors with Research	-	-	-	-	-		-	4	4*
				Total	**TH:TU:PR 16:0:12=28**			-		**1100**	-	**22**

SEM-IV												
Course Code	Course Vertical	Sub-Vertical	Course Name		Contact Hours	Examination Marks (1 Credit=50 Marks)					Credits	
						ISE	MSE	ESE		Total	Points	Total
								Min	Max			
25BSC12CS06	BSESC	BSC	Linear Algebra and Business Statistics	TH	2	20	30	20	50	100	2	3
				TU	1	50	-	-		50	1	
				SL	3							
25PCC12CS08	PCPEC	PCC	Computer Organization and Architecture	TH	2	20	30	20	50	100	2	2
				SL	2							
25PCC12CS05	PCPEC	PCC	Analysis of Algorithms	TH	2	20	30	20	50	100	2	3
				PR	2	50	-	-		50	1	
				SL	2							
25PCC12CS10	PCPEC	PCC	Data Analytics and Visualization	TH	2	20	30	20	50	100	2	3
				PR	2	50	-	-		50	1	
				SL	2							
25PCC12CS11	PCPEC	PCC	Competitive coding lab	PR	2	50	-	-		50	1	1
25OE12CS2X	MDC	OE	1. Emerging Technology and Law 2. Principles of Management	TH	2	100	-	-		100	2	2
				SL	2							
25VSE12CS03	SC	VSEC	Web Programming	PR	4	100	-	-		100	2	2
25MDMXX3	MDC	MDM	MDM Course-3	TH	2	20	30	20	50	100	2	2
				SL	2							
25EEM12CS02	HSSM	EEMC	Technology Entrepreneurship	TH	2	100	-	-		100	2	2
				SL	2							
25VEC12CS02	HSSM	VEC	Technology Innovation for Sustainable Development	TH	1	100	-	-		100	1	2
				PR	2						1	
				SL	1							
25DMX2	DM	DM	Double Minor Course-2	TH	2	20	30	20	50	100	2	4*
				TU	2	50	-	-		50	2	
25HR02	HR	HR	Honors with Research	-	-	-	-	-		-	4	4*
25BC	BC	BC	MOOC	-	-	-	-	-		-	-	2$
				Total	**TH:TU:PR 15:1:12=28**			-		**1100**	-	**22**

$ Discipline specific additional course to Lateral Entry (Diploma) students from Swayam Plus/Swayam platform

Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25BSC12CS05	Discrete Maths and Statistics	2	0	0	2	2	--	--	2
		Examination Scheme							
			ISE	MSE		ESE		Total	
		Theory	20	30		50		100	

Pre-requisite Course Codes		Matrices and Differential Calculus, Integral Calculus and Probability Theory
After the successful completion students should be able to:		
Course Outcomes	CO1	Apply propositional and predicate logic to solve problems and represent mathematical statements
	CO2	Analyze the implications of different types of relations and functions in various mathematical and real-world contexts
	CO3	Classify algebraic structures, Groups, Rings and solve problems using algebraic structures.
	CO4	Solve the real-world problems based on sampling and Normal probability distributions
	CO5	Develop and test a hypothesis about the population parameters to draw meaningful conclusions.

Module No.	Unit No.	Topics	Ref.	Hrs.
1	1.1	**Logic**: Propositional Logic, Predicate Logic, Laws of Logic, Quantifiers, Normal Forms, Mathematical Induction.	1,2,4	3
2	2.1	**Relations**: Definition, Types of Relations, Representation of Relations, Closures of Relations, Warshall's algorithm, Equivalence relations and Equivalence Classes	1,2	6
	2.2	**Functions**: Definition, Types of functions, Composition of Functions, Invertible functions, Recursive functions		
	2.3	**Lattice**: Definition, Properties of Lattice, Sub lattice, Isomorphic Lattices		
3	3.1	**Algebraic structures**: Semi group, Monoid, Groups, Subgroups, Abelian Group, Cyclic group, Isomorphism, Ring	1,2,3	4
4	4.1	**Discrete & Continuous Probability Distributions**: Random variable, probability distribution, Std. deviation, variance, Binomial, Poisson and Normal Probability Distribution, Normal Curve, Standard Normal Probability Distribution	5	6
	4.2	**Sampling:** Sampling Methods, Central Limit theorem, Confidence Interval Estimation		
5	5.1	**Hypothesis Tests**: Developing Null and Alternative Hypotheses, Type I and Type II Errors, Population Mean: Known, Population	5	7

		Mean: Unknown, Inference About Means and Proportions with Two Populations		
	5.2	**Tests of Goodness of Fit and Independence:** Goodness of Fit Test: A Multinomial Population, Test of Independence		
			Total	**26**

Self-Learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment:

ISE: ISE activities carry 20 marks. These activities will be conducted throughout the semester.
MSE: The written summative examination of 30 marks based on 50% syllabus for 90 minutes.
ESE: The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Recommended Books:

1. Rosen Kenneth: "Discrete Mathematics and its applications." McGraw Hill-New Delhi.
2. C. L. Liu, D. P. Mohapatra: "Elements of discrete mathematics: a Computer Oriented approach", 4th Edition, McGraw Hill-New Delhi.
3. B. Kolman, R. Busby, S. Ross: "Discrete Mathematical Structures",6th Edition, Pearson
4. Gary Haggard, John Schlipf, Sue Whitesides: "Discrete Mathematics for Computer Science", Thomson Brooks/Cole Publication
5. David R. Anderson, Dennis J. Sweeney, Thomas A. Williams: "Statistics for Business and Economics"11th Edition, South-Western, Cengage Learning

Suggested CO - PO Articulation Matrix

Course Outcomes	Programme Outcomes (POs)										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3			2						
CO2	3	3	2		2						
CO3	3	3	2								
CO4	3	3		3	2						
CO5	3	3		3	2						

Legends: - High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms level

Remember	Understand	Apply ✓	Analyze ✓	Evaluate ✓	Create

Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25PCC12CS09	Database Management System	2	--	2	2	2	--	1	3
		Examination Scheme							
			ISE			MSE	ESE	Total	
		Theory	20			30	50	100	
		Lab	50			--	--	50	

Pre-requisite Course Codes		-----
After the successful completion students should be able to:		
Course Outcomes	CO1	Recognize the need of Database management Systems
	CO2	Design ER/EER Model for real life applications and convert it into relational model
	CO3	Apply Relational Algebra operation to perform operation on database
	CO4	Implement SQL commands for given task
	CO5	Apply normalization to database design to remove redundancies
	CO6	Describe concurrency control mechanism to achieve serializability and deadlock Handling

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Introduction**	1,2	2
	1.1	Introduction, Characteristics of databases, File system v/s Database system,		
	1.2	Data abstraction and data Independence, DBMS system architecture, Database Administrator		
2		**Entity–Relationship Data Model**	1,2	4
	2.1	The Entity-Relationship (ER) Model: Entity types: Weak and strong entity sets, Entity sets, Types of Attributes, Keys, Relationship constraints: Cardinality and Participation		
	2.2	Extended Entity-Relationship (EER) Model: Generalization, Specialization and Aggregation		
	2.3	Introduction to the Relational Model, ER to relational model rules and problems, Case studies and practice problems		
3		**Relational Algebra**	1,2	2
	3.1	Introduction to relational query language, Role of Relational Algebra in DBMS, Relational Algebra operators and Queries, Conversion of Relational Algebra into SQL		
4		**Structured Query Language (SQL)**	1,2	6
	4.1	Overview of SQL, Data Definition Language Commands, key constraints, Domain Constraints		
	4.2	Data Manipulation commands, DQL, Aggregate function-group by, having, Views in SQL, joins, Nested and complex queries, Data Control commands, Set and string operations, Triggers, PLSQL		

5		**Relational-Database Design**	1,2	6
	5.1	Pitfalls in Relational-Database designs, Concept of normalization, Function Dependencies, First Normal Form, 2NF, 3NF, BCNF. Converting Relational Schema to higher normal form, Problems based on Normalization		
6		**Transactions Management, Concurrency and Recovery**	1	6
	6.1	Transaction concept, Transaction states, ACID properties, Transaction Control Commands, Concurrent Executions, Serializability-Conflict and View, Problems based on Conflict and View Serializability, Concurrency Control: Lock-based, Timestamp-based protocols, Recovery System: Log based recovery, Deadlock handling		
			Total	**26**

Self-Learning:
1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment:

Theory:

ISE: ISE activities carry 20 marks. These activities will be conducted throughout the semester

MSE: The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE: The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Lab:

ISE: Laboratory ISE is divided into two components: 25 marks for submission of experiments and 25 marks for oral/practical evaluation.

Module No.	Exp. No.	Suggested List of experiments
1,2	1	Identify the case study and detail statement of problem. Design an Entity Relationship (ER) / Extended Entity-Relationship (EER) Model
1,2	2	Convert ER/EER model to relational model
4	3	Create and populate database using Data Definition Language (DDL) and DML Commands for the specified System without integrity constraint.
4	4	Create and populate database using Data Definition Language (DDL) and DML Commands for the specified System with integrity constraint
4	5	Perform Simple queries and Date operations
4	6	Perform Join operations and Complex queries
4	7	Perform nested sub-queries in SQL
4	8	To implement PL/SQL and Procedures and Functions

4	9	To implement Triggers and Cursors
6	10	To implement Transaction and Concurrency control
	11	Exposure to MongoDB
	12	Mini project for Real life Scenario

Recommended Books:

1. Korth, Siberchatz, Sudarshan, Database System Concepts, 6thEdition, McGraw Hill
2. Elmasri and Navathe, Fundamentals of Database Systems, 5thEdition, Pearson Education
3. Raghu Ramkrishnan and Johannes Gehrke, Database Management Systems, TMH
4. Peter Rob and Carlos Coronel, Database Systems Design, Implementation and Management‖, Thomson Learning, 5thEdition.
5. Dr. P.S. Deshpande, SQL and PL/SQL for Oracle 10g, Black Book, Dreamtech Press.
6. G. K. Gupta, Database Management Systems, McGraw Hill, 2012
7. Michael Kaufmann, Andreas Meier, SQL and NoSQL Databases: Modeling, Languages, Security and Architectures for Big Data Management

Online Repository:

1. https://www.db-book.com/db6/slide-dir/index.html-Korth , Siberchatz, Sudarshan, 6th Edition
2. http://www.tutorialspoint.com/sql/
3. https://www.w3schools.com/sql/default.asp
4. http://www.mysqltutorial.org/ or https://www.tutorialspoint.com/postgresql/
5. https://academy.vertabelo.com/course/standard-sql-functions#
6. https://www.postgresqltutorial.com/postgresql-grouping-sets/
7. https://www.pgtutorial.com
8. https://www.freeprojectz.com/entity-relationship-diagram
9. https://www.w3schools.com/sql/sql_any_all.asp

Suggested CO - PO Articulation Matrix

Course Outcomes	Programme Outcomes (POs)										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3										
CO2	3	3	3					3	3	2	2
CO3	3	3									
CO4	3	3									
CO5	3	3									
CO6	3	3	2								

Legends: - High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms Level

Remember	Understand	Apply ✓	Analyze ✓	Evaluate ✓	Create

Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
		2	1	2	3	2	1	1	4
25PCC12CS06	Data Structures	Examination Scheme							
			ISE	MSE	ESE	Total			
		Theory	20	30	50	100			
		Lab	50	--	--	50			
		Tutorial	50	--	--	50			

Pre-requisite Course Codes		25ESC11CS02
Course Outcomes	CO1	Implement various operations of linear data structures.
	CO2	Implement various operations of non-linear data structures.
	CO3	Implement appropriate searching and hashing techniques on a given problem
	CO4	Apply appropriate data structure to solve different computing problems.

Module No.	Unit No.	Topics	Ref.	Hrs
1	1.1	**Introduction:** Introduction to Data Structures, Concept of ADT, Types of Data Structures: Linear and Nonlinear	1,2,3	3
2	2.1	**Stack and Queue:** **Stack:** Introduction, Stack as ADT, Operations, Implementation using array, Applications of stack: Infix to Postfix conversion, Evaluation of Postfix using stack	1,2,3	5
	2.2	**Queue:** Introduction, Queue as ADT, Operations, Implementation using array, Types of queue - Circular queue, Priority queue, Double ended queue, operations on these queues.	1,2,3	6
3	3.1	**Linked List:** Linked list as an ADT, Types of Linked List: Singly Linked List, Doubly linked list, Circular linked list concept, Operation on Singly and Doubly linked list, Applications of Linked List: Stack and Queue using Linked List. Polynomial representation and addition of two polynomials using Linked List.	1,2,3	8
4	4.1	**Tree:** Basic Terminology, Array and Linked Representation of Binary Tree ADT, Traversal of Binary Tree, Binary Search Tree and operations on it, AVL trees, Rotations, Operations on AVL Tree, Applications of these binary trees. Introduction to B tree and B+ tree.	1,2,3	8
5	5.1	**Graphs:** Basics Terminology, Adjacency List and Adjacency Matrix Representation, Graph traversals BFS and DFS.	1,2,3	5
6	6.1	**Searching Techniques and Hashing:** Linear Search and Binary Search, Hashing: Basic concepts, Hash function, Collision Resolution Techniques.	2,3	4
Total				**39**

Self-Learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Self-Learning References:

1. https://www.geeksforgeeks.org/dsa/data-structures-and-algorithms-online-quiz/
2. https://leetcode.com/problem-list/linked-list/
3. https://www.geeksforgeeks.org/dsa/real-time-application-of-data-structures/
4. https://www.geeksforgeeks.org/dsa/introduction-to-red-black-tree/
5. https://www.geeksforgeeks.org/dsa/difference-between-min-heap-and-max-heap/
6. https://www.geeksforgeeks.org/dsa/counting-frequencies-of-array-elements/
7. https://www.geeksforgeeks.org/dsa/ternary-search/

Course Assessment:

Theory:

ISE: Based on Self-Learning / Formative assessment activities will be conducted during the full semester - 20 Marks

MSE: 90 minutes 30 Marks written examination based on 50% syllabus

ESE: ESE examination will be written summative examination for 50 marks based on full syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes

Practical:

ISE: Laboratory ISE is divided into two components: 25 marks for submission of experiments and 25 marks for oral/practical evaluation.

Tutorial: Assessment shall be based on five tutorials, with each tutorial carrying 10 marks, evaluated through continuous assessment of analytical thinking, problem-solving skills, logical circuit design, and accuracy of solutions.

Exp. No.	Name of the Experiment	CO
1	Implement a given problem using Stack. (Basic and Applications)	CO1
2	Implement a given problem using Queue. (Basic and Applications)	CO1
3	Implement a given problem using Singly Linked List. (Basic and Applications)	CO1
4	Implement a given problem using Doubly Linked List.	CO1
5	Implement a given problem using Binary Search Tree. (Basic and Applications)	CO2
6	Implement Min Heap and Max Heap operations / create a priority queue using Heap.	CO2, CO3

7	Apply graph traversal techniques (BFS and DFS) to solve a given problem.	CO2
8	Implement hash functions with different collision resolution techniques (chaining, open addressing).	CO4
9	Mini Project: Develop a working prototype demonstrating real-life applications of data structures.	CO1, CO2, CO3, CO4

Recommended Books:

1. "Data Structures using C and C++" by Yedidyah Langsam, Moshe J. Augenstein, Aaron M. Tenenbaum, 2nd edition, Prentice Hall
2. "Data Structures using C", Reema Thareja, Third Edition, Oxford University Press.
3. "Data Structures and Program Design in C++", Robert L. Kruse, Alexander J. Ryba, Prentice-Hall India.
4. "Data Structures and Algorithm in Java", Goodrich and Tamassia, John Wiley and Sons, Sixth Edition 2014. John Wiley & Sons.
5. "Data Structures and Pseudocode approach with C", 2nd Edition by Richard F. Gilberg; Behrouz A. Forouzan, Thomson Publishing.

Online Resources:

1. https://nptel.ac.in/courses/106/102/106102064/
2. https://www.coursera.org/specializations/data-structures-algorithms
3. https://visualgo.net
4. www.leetcode.com
5. www.hackerrank.com
6. www.codechef.com

Suggested CO - PO articulation Matrix

Course Outcomes	Programme Outcomes (POs)										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	2	2		2	-	-	2	2	-	2
CO2	2	2	2		2	-	-	2	2	-	2
CO3	2	2	2		2	-	-	2	2	-	2
CO4	2	2	2		2	-	-	3	2	-	2

Legends:- High: 03, Medium: 02,Low: 01, No Mapping: -

Remember	Understand	Apply	Analyze	Evaluate	Create
		√			

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
25PCC12CS07	Object Oriented Programming with JAVA	-	--	2	-	--	1	1
		Examination Scheme						
			ISE		MSE	ESE	Total	
		Lab	50		--	--	50	

Pre-requisite Course Codes		--
After the successful completion students should be able to:		
Course Outcomes	CO1	Demonstrate Proficiency in Core Java Concepts
	CO2	Apply Object-Oriented Programming Principles
	CO3	Explore Java programming concepts including multithreading, File I/O, and exception handling
	CO4	Develop and Debug Java Applications

Exp. No.	Topics	Ref.	Hrs.
1	**Introduction to Java Basics:** Overview of Java programming language, setting up the development environment (IDE installation), Writing and executing your first Java program, Understanding variables and data types, Basic input/output operations, Control Structures and Functions **Suggested Experiment List: (Any One)** **Coffee Shop Problem** Develop a program for a coffee shop that calculates the total cost of a customer's order, including taxes and discounts, and prints the receipt. **Temperature conversion tool Problem Statement:** Create a temperature conversion tool that converts Celsius to Fahrenheit and vice versa, based on user input. Parking Fee Calculator Problem Statement: Implement a parking fee calculator that calculates the parking charges based on the duration of parking and the type of vehicle.	1,2,3,4	2
2	**Introduction to object-oriented programming (OOP) concepts:** Classes and objects in Java, Encapsulation, Association, and polymorphism **Suggested Experiment List: (Any One)** **Banking Application** Design a simple banking application that allows users to deposit, withdraw, and check their account balance. **Student Management System** Create a student management system that stores student information (name, roll number, marks) and provides functionality to add, delete, and update student records.	1,2,3,4	2
3	**Inheritance:** Types of Inheritance, Interface , Abstract class and methods, super and final keywords **Suggested Experiment List: (Any One)** **Shape Drawing Application** Design a shape drawing application that allows users to draw different shapes (circle, rectangle, triangle) on a canvas and perform operations like resizing and rotating.	1,2,3,4	4

	Employee Payroll Processing Create a program for managing employee payroll information, including salary calculation, deductions, and tax withholding. Allow HR personnel to add new employees, update salary information, and generate pay stubs.		
4	**Arrays, Set, List, Map and Vector:** Arrays, Set, List and Map in Java, Vector. **Suggested Experiment List: (Any One)** Library Management App: Develop a program for a library that manages book inventory, allowing users to search for books by title or author **Contact Management App:** Build a contact management application that stores contact information (name, phone number, email) and provides features like searching, sorting, and exporting contacts.	1,2,3,4	2
5	**Strings:** Introduction to strings and string manipulation**,** StringBuilder, StringBuffer, Regex basics **Suggested Experiment List: (Any One) String Encoding:** Design a Java application that efficiently compresses a given string using any encoding technique, balancing between compression ratio and computational complexity. **Log File Analyzer:** Design a Java program that applies object-oriented design to filter, categorize log file data for effective system monitoring. **Password strength checker:** Design a Java-based password strength checker that classifies passwords as weak, moderate, or strong	1,2,3,4	2
6.1	**Exception Handling:** Handling exceptions in Java (try-catch-throw-throws finally), Checked vs Unchecked exceptions, Exception hierarchy, User defined Exceptions, Custom exception design. **Suggested Experiment List: (Any One)** **Flight Booking System** Develop a program for a flight booking system that handles exceptions such as invalid input, seat availability, and payment errors. **Transportation Management** Create a Java program for a transportation management system that handles exceptions related to route planning, vehicle breakdowns, traffic congestion, and delivery delays. Implement resilience patterns like circuit breakers and retry mechanisms."	1,2,3,4	4
7	**Multithreading:** Introduction to Multithreading- lifecycle, creation of threads. Synchronization and Thread Communication, Handling Thread Interruption and Thread Pools. **Suggested Experiment List: (Any One)** **Chat Application** Develop a real-time chat application that allows multiple users to communicate with each other concurrently using separate threads for sending and receiving messages. **Social Media Platform**	1,2,3,4,5	4

	Build a simple social media platform where users can create profiles, connect with friends, and share posts. Implement features such as news feed, notifications, and privacy settings.		
8	**Introduction to REST API:** Basic REST API using java. **Suggested Experiment:** Build an application for REST API using JAVA	6	2
9	**Database Connection with Java:** Setting Up Database Environment (MySQL/PostgreSQL), Establishing Database Connection, Executing SQL Queries, basics of Exception Handling **Demonstration** Program on Database Connection and Queries handling	1,2,3,4	2
10	**File Handling:** File Input / Output with Streams, Serialization and Deserialization, Random Access Files **Suggested Experiment List: (Any One)** **File Master App** Create a file management tool that allows users to organize and manage files and folders on their computer, including operations like creating, deleting, and renaming files. **Weather Forecasting** Application Develop a weather forecasting application that retrieves data from a file and displays current weather conditions and weather stats.	1,2,3,4	4
11	**Mini Project:** Defining the problem statement and objectives. Create UML diagram (Class diagram/ Usecase diagram) Implement the idea of Mini Project based on the content of the syllabus(Group of 2-3 students)		
		Total	**28**

Course Assessment:

ISE: Laboratory ISE is divided into two components: 25 marks for submission of experiments and 25 marks for oral/practical evaluation.

Recommended Books:

1. Herbert Schildt, "Java: The Complete Reference", Nineth edition, McGraw Hill Education Publication
2. E. Balaguruswamy, "Programming with JAVA", Sixth edition, McGraw Hill Education Publication
3. Kathy Sierra and Bert Bates, "Head First Java: A Brain-Friendly Guide, 2Nd Edition", O'REILLY publication
4. Joshua Bloch, "Effective Java", third edition, Addison-Wesley Professional publication
5. Brian Goetz et al., "Java Concurrency in Practice", first edition, Addison-Wesley Professional publication
6. Mark Heckler, Gerrit Grunwald, José Pereda, Sean Phillips, Carl Dea, "JavaFX 8: Introduction by Example" second edition, Apress publication

Online Repository:

1. https://www.scaler.com/topics/course/java-beginners/
2. https://www.udemy.com/course/practical-java-course/
3. https://www.coursera.org/learn/object-oriented-java
4. https://www.mygreatlearning.com/academy/learn-for-free/courses/java-programming
5. https://www.upgrad.com/free-courses/it-technology/free-core-java-course-basics/

Suggested CO - PO Articulation Matrix

Course Outcomes	Programme Outcomes (POs)										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3									
CO2	3	3									
CO3	3	3									
CO4	3	3			3			3	3	3	3

Legends: - High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms Level

Remember	Understand	Apply ✓	Analyze	Evaluate	Create

Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
		2	--	-	2	2	--	--	2
25OE12CS11	Law for Engineers	Examination Scheme							
			ISE			MSE	ESE	Total	
		Theory	100			--	--	100	
		Lab	--	--		--	--	--	

Pre-requisite Course Codes		--
After the successful completion students should be able to:		
Course Outcomes	CO1	Demonstrate awareness of basic structure of Indian Legal System
	CO2	Demonstrate awareness of principles of contract
	CO3	Demonstrate awareness of legal aspects related to establishment of factory and various legislations related to employees, labours, and workmen's welfare
	CO4	Demonstrate awareness about right of information, intellectual creations from infringement and laws related to energy, food and environment

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Foundation of Legal System**	1,2,3	4
	1.1	Indian Legal System: An Introduction, Human Rights, Fundamental Rights, The Supreme Court of India, Statutory Commissions– NHRC, NCW, NCM, NC-SC/ST etc., Writs in Indian constitution.		
	1.2	Representation of Peoples Act 1950, Prevention of Corruption Act, 1988, Understanding the Importance of Stamp Duty		
	1.3	Few Illustrated Cases of Supreme Court of India		
2		**General Principles of Contract: India Contract Act 1872**	2,3	8
	2.1	Contract Law: Agreement and Its Kinds,		
	2.2	Who Can Enter into a Contract, Contract and Its Enforceability, Offer and Acceptance in a Contract,		
	2.3	Essentials of Valid Contract- Lawful Consideration and Lawful Object, Essentials of Valid Contract- Free Consent,		
	2.4	Types of Contract, Contract of Agency, Performance of Contracts, Government Contracts, Standard Form Contracts		
3		**Industrial and Labour Laws**	2,3	8
	3.1	Labour Laws in India: An Overview, Industrial Disputes Act, 1947, Industrial Employment (Standing Orders) Act, 1946		
	3.2	Factories Act, 1948, Industries (Development and Regulation) Act, 1951		
	3.3	Contract Labour (Regulation and Abolition) Act, 1970, Bonded Labour System (Abolition) Act, 1976, Child and Adolescent Labour (Prohibition and Regulation) Act, 1986		

	3.4	Workmens Compensation Act, 1923, Equal Remuneration Act, 1976, Payment of Bonus Act, 1965, Payment of Gratuity Act, 1972, Employees' State Insurance Act, 1948, Employees' Provident Funds and [Miscellaneous Provisions] Act, 1952,		

Self-Learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.

2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment:

ISE: ISE activities carry 100 marks. These activities will be conducted throughout the semester.

Recommended Books:

1. N. S. Nappinai, "*Technology Laws Decoded*," LexisNexis, 2017
2. Vibha Arora and Kunwar Arora, "*Law for Engineers*" Central Law Publications, 2017
3. Vandana Bhatt and Pinky Vyas, "*Laws for Engineers*", ProCare, 2015.
4. Family Law by Paras Diwan, ALLAHABAD LAW AGENCY, 14th Edition, 2025
5. Avtar Singh's Law of Contract & Specific Relief by Rajesh Kapoor, Eastern Book Company.
6. New Labour and Industrial Laws Bare Act with Short Comments, Diglot Edition 2026 (Law Of Prevention Of Money Laundering) by Whitesmann.
7. Law Relating to Intellectual Property by B L Wadehra, Lexis Nexis.

Online Repository:

1. https://www.sci.gov.in.
2. https://www.youtube.com/watch?v=skR6Z6TwdcM.
3. https://www.youtube.com/watch?v=ZaUePaAuZ4Q
4. https://www.youtube.com/watch?v=cQQHv7mzvHU.
5. https://www.youtube.com/watch?v=eLnXaTCbuAo
6. https://www.legalserviceindia.com/legal/article-9960-5-types-of-writs-in-indian-constitution
7. https://doe.gov.in/files/inline-documents/DoE_Prevention_sexual_harassment.pdf
8. https://www.greythr.com/notifications/sexual-harassment-of-women-at-workplace-prevention-prohibition-and-redressal-amen
9. https://cag.gov.in/uploads/cms_pages_files/Vishkha-Guidelines-against-Sexual-Harassment-in-Workplace-061de8308de91c7-65164897.pdf
10. https://www.mshrc.gov.in › vishakha-guidelines

Suggested CO - PO Articulation Matrix

Course Outcomes	Programme Outcomes (POs)										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	-	-	-	1	3	3	3	3	3	-
CO2	2	-	-	-	3	2	3	2	1	1	-
CO3	3	-	-	-	1	1	1	3	3	3	-
CO4	2	-	-	-	3	2	3	3	2	2	-

Legends:- High: 03, Medium: 02,Low: 01, No Mapping: -

Blooms Level

Remember	Understand	Apply	Analyze ✓	Evaluate	Create

Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25OE12CS12	Financial Planning, Taxation, and Investment	2	--	--	2	2	--	--	2
		Examination Scheme							
				ISE		MSE	ESE	Total	
		Theory		100		--	--	100	
		Lab		--		--	--	--	

Pre-requisite Course Codes		--
After the successful completion students should be able to:		
Course Outcomes	CO1	Prepare financial plan by understanding owns need
	CO2	Demonstrate awareness of taxation policies and show respect towards government norms and regulations
	CO3	Prepare investment plan by understanding owns futuristic needs

Financial Planning: It is possible to manage income more effectively through financial planning. Managing income helps to understand how much money is required for tax payments, other expenditures, and savings. It increases cash flows by carefully monitoring the spending patterns and expenses. Knowledge of comprehensive financial planning will help students to make right financial decisions in their life. It gives guidance in helping choose the right types of investments to fit needs, personality, and goals of their life. In this activity students need to prepare the financial plan for their life.

Taxation Policies: Taxes are levied in almost every country of the world, primarily to raise revenue for government expenditures, although they serve other purposes as well. The simple fact in economics is that there are certain common public goods and public needs that require some form of government and regulation to provide or promote. Taxation is the way to pay for these common goods. In this activity student will learn various types of taxes like Income tax, Corporate tax, Capital gains, Property tax, Inheritance and Sales tax.

Investments: Investments are important because in today's world, just earning money is not enough. But that may not be adequate to lead a comfortable lifestyle or fulfil our dreams and goals. Money lying idle in the bank account is an opportunity lost. Therefore, students should have a knowledge to invest money smartly to get good returns out of it. This activity will give insight to the students about investment in the form of Stocks, Mutual Funds, Fixed Deposits, Recurring Deposit, Public Provident Fund, Employee Provident Fund and National Saving Schemes.

Methodology: Guest lectures or workshops by professionals shall be arranged on Financial Planning, Taxation, and Investments. Invite guest speakers, such as tax professionals or financial advisors, shall conduct a tax planning workshop for students. The workshop can cover topics such as tax-efficient investment strategies, retirement planning, and tax-saving opportunities for individuals and businesses. Students should be engaged in assessment driven activities throughout the course. For better learning outcomes following methods of content delivery via student engagement can be adopted.

Investment Simulation Game: Divide students into groups and have them participate in a simulated investment game. Each group is given a virtual budget to invest in stocks, bonds, mutual funds, or other investment vehicles. Throughout the course, they track the performance of their investments and make decisions based on real-world market trends and economic indicators.

Financial Planning Board Game: Design a board game that simulates the process of financial planning, including setting financial goals, creating budgets, managing debt, and making investment decisions. Students play the game in groups, competing or collaborating to achieve their financial objectives.

Stock Market Simulation: Use online stock market simulation platforms that allow students to buy and sell stocks in a virtual trading environment. They can experiment with different investment strategies, track the performance of their portfolios, and compete against their classmates or other teams.

Course Assessment:

ISE: Activities as a formative assessment for 100 marks.
Quiz: 20 Marks
Activity: Presentation on Financial Instruments: 10 Marks
Activity: Preparing Investment Portfolio (20 Marks): Assign each student or group of students to create a hypothetical investment portfolio based on specific criteria such as risk tolerance, time horizon, and financial goals. They research different investment options, analyze their potential returns and risks, and justify their portfolio allocations in a written report or presentation.

Quiz: 20 Marks
Activity: Tax Return Case Studies (*Perquisite: Pan Card (if not available, student should immediately apply and get pan card))* (10 Marks): Consider case study of fictional individuals or families and prepare tax returns based on their financial situations. This hands-on activity allows students to apply their knowledge of taxation laws and regulations in a practical context.

Activity: Financial Literacy Podcast (10 Marks): Have students create their own podcasts or audio recordings discussing key concepts related to financial planning, taxation, and investments. They can *interview experts*, share personal finance tips, or discuss current events and trends in the financial industry.

Activity: Personal Finance Blog (10 Marks): Students create their own personal finance blogs or websites where they share articles, tutorials, and resources related to financial planning, taxation, and investments. This activity helps them develop their writing and research skills while sharing valuable information with their peers.

Self-Learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.

2. Evaluation of the self-learning components is carried out in all the evaluation components.

Suggested CO - PO articulation Matrix

Course Outcomes	Programme Outcomes (POs)										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	-	2	-	2	-	-	-	-	-	2	2
CO2	-	2	-	-	-	2	-	2	-	2	-
CO3	-	3	2	-	-	-	-	-	-	2	2

Legends :- High: 03, Medium: 02,Low: 01, No Mapping: -

Blooms level

Remember ✓	Understand ✓	Apply ✓	Analyze	Evaluate	Create

Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25AEC12CS021	Sanskrit for Beginners	2	--	--	2	2	--	--	2
		Examination Scheme							
			ISE			MSE	ESE	Total	
		Theory	100			--	--	100	
		Lab	--			--	--	--	

Pre-requisite Course Codes		Basic Language skills
After the successful completion students should be able to:		
Course Outcomes	CO1	Demonstrate understanding of the Fundamentals of Sanskrit Language
	CO2	Apply Vocabulary and grammar skills for day-to-day conversation
	CO3	Developing Speaking and Learning skills

Module No.	Unit No.	Topics	Ref.	Hrs.
1	1.1	Introduction: Some Unique characteristics of Sanskrit The Sounds of Sanskrit: Its Alphabet Sentence Construction and Its underlying logic Introduction of Self and Others Basic verbs and some conjugations	1-8	6
2	2.1	Introduction to Genitive (6^{th} Case) Counting and Reading the Time Plural of Pronouns and Nouns Conjugation of Basic Verbs in the Plural Introduction to the Locative (7^{th} Case)	1-8	6
3	3.1	Days of the week, Months, Future Tense Past Tense and More Verbs Introduction to the Accusative (2^{nd} Case) Introduction to the Instrumental (3^{rd} Case)	1-8	6
4	4.1	Introduction to the Ablative (5^{th} Case) Introduction to the Dative (4^{th} Case) Introduction to the Vocative (8^{th} Case)	1-8	6
	4.2	Stories and Motivational Shlok with word by word meaning	1-8	2
			Total	**26**

Course Assessment:

ISE: ISE activities carry 100 marks. These activities will be conducted throughout the semester.

Recommended Books:

1. Kumari, S. "Sanskrita Chitrapada koshah," Mysuru: Bharatiya Bhasha Sansthanam, 1993
2. Samkrita-vyavahaara-sahasri (Samskrit-English), New Delhi: Sanskrita Bharati
3. Sampad, & Vijay, "The Wonder that is Sanskrit" Pondicherry: Sri Aurobindo Society, 2005.
4. Satvlekar, S. D. "Sanskrit Swayam Shikshak," Delhi: Rajpal & Sons, 2013
5. Shastri, V K. "Teach Yourself Samskrit: Prathama Diksha" Delhi: Rashtryia Sanskrita Samsthana, 2012
6. Vishwasa "Abhyāsa-pustakam", New Delhi: Samskrita Bharati, 2014

Online Repository:

1. https://onlinecourses.nptel.ac.in/
2. https://www.learnsanskrit.org/

Self-Learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.

2. Evaluation of the self-learning components is carried out in all the evaluation components.

Suggested CO - PO Articulation Matrix

Course Outcomes	Programme Outcomes (POs)										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3								3		3
CO2	3								3		3
CO3	3								3		3

Legends:- High: 03, Medium: 02,Low: 01, No Mapping: -

Blooms Level:

Remember ✓	Understand	Apply	Analyze	Evaluate	Create

Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25AEC12CS022	Telugu for Beginners	2	--	--	2	2	--	--	2
		Examination Scheme							
			ISE		MSE	ESE	Total		
		Theory	100		--	--	100		
		Lab	--		--	--	--		

Pre-requisite Course Codes		--
After the successful completion students should be able to:		
Course Outcomes	CO1	Recognize Telugu alphabets and read simple Telugu words with correct pronunciation.
	CO2	Construct simple Telugu sentences using basic grammar and vocabulary.
	CO3	Communicate in Telugu using simple conversations in everyday situations.

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Introduction to Telugu Language and Basic Communication			
	1.1	**Introduction to Telugu Language and Script:** Features of Telugu language and script. Telugu vowels and consonants. Formation of simple words.	1	3
	1.2	**Reading and Pronunciation Practice:** Reading simple Telugu words. Pronunciation practice. Recognition of commonly used words.	1	3
	1.3	**Basic Spoken Telugu:** Greetings and introductions. Asking simple questions. Common polite expressions.	1	3
2	Basic Grammar and Sentence Formation			
	2.1	**Basic Sentence Formation:** Formation of simple Telugu sentences. Question and answer forms. Use of common verbs.	2	3
	2.2	**Functional Grammar:** Use of present, past and future tense. Use of adjectives. Negative and interrogative sentences.	2	3
3	Vocabulary Development and Everyday Communication			
	3.1	**Practical Vocabulary:** Numbers and time expressions. Words related to home and daily activities.	3	3
	3.2	**Everyday Communication:** Asking directions. Shopping conversations. Travel-related expressions.	3	3
4	Conversational Telugu and Speaking Practice			
	4.1	**Conversational Telugu:** Conversations in practical situations such as classroom, market and public places.	3	2
	4.2	**Interactive Speaking Practice:** Dialogue practice. Listening exercises. Group speaking activities.	3	3
			Total	**26**

Self-Learning:
1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment:
ISE: ISE activities carry 100 marks. These activities will be conducted throughout the semester.

Recommended Books:

1. Sanjay,D, " Spoken Telugu for Absolute Beginners", Notion Press, 2019.
2. Praveen Ragi, "Learn Telugu Through English. V1" Evincepub Publications, 2020
3. Oxford compact English-English Telugu Dictionary
4. English- Telugu Conversation guide / Aarthi Janyavula , 2018

Suggested CO - PO articulation Matrix

Course Outcomes	Programme Outcomes (POs)										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1									2		1
CO2								1	3		1
CO3								2	3		1

Legends: - High: 03, Medium: 02,Low: 01, No Mapping: -

Blooms level

Remember	Understand	Apply ✓	Analyze	Evaluate	Create

Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25AEC12CS023	Kannada for Beginners	2	--	--	2	2	--	--	2
		Examination Scheme							
			ISE			MSE	ESE	Total	
		Theory	100		--	--	--	100	
		Lab	--		--	--	--	--	

Pre-requisite Course Codes		--
After the successful completion students should be able to:		
Course Outcomes	CO1	Demonstrate basic understanding of Kannada alphabets, pronunciation and grammar.
	CO2	Use Kannada vocabulary and simple sentence structures in daily communication.
	CO3	Communicate in Kannada using simple conversations in common real-life situations.

Module No.	Unit No.	Topics	Ref.	Hrs.
1	**Introduction to Kannada Language and Basic Communication**			
	1.1	**Introduction to Kannada Language:** Origin and development of Kannada language. Importance of Kannada in daily communication.	1	2
	1.2	**Kannada Alphabets:** Learning Kannada vowels and consonants. Writing practice and visual learning.	1	2
	1.3	**Pronunciation Practice:** Pronunciation of alphabets and simple words. Reading basic Kannada words.	1	2
	1.4	**Basic Expressions:** Greetings and common expressions used in daily communication.	1	2
2	**Basic Grammar and Sentence Formation**			
	2.1	**Basic Grammar and Sentence Formation:** Basic sentence structure. Subject–Verb–Object patterns. Simple sentence formation.	2	2
	2.2	**Tenses and Adjectives:** Present tense, past tense and future tense. Use of simple adjectives.	2	2
	2.3	**Nouns and Pronouns:** Common nouns and pronouns. Simple negative sentences.	2	2
3	**Vocabulary Development and Everyday Expressions**			
	3.1	**Vocabulary Development:** Numerals from 1–20 and 100–1000. Common vocabulary words.	3	2
	3.2	**Common Expressions:** Useful expressions in everyday communication.	3	2
	3.3	**Daily Life Vocabulary:** Days of the week. Months of the year. Food items. Body parts. Common places and weather.	3	2
4	**Conversational Kannada and Practical Communication**			
	4.1	**Conversational Kannada:** Simple conversations in daily situations such as classroom, market, transport and hospital.	3	3

	4.2	**Role Play Activities:** Role-play exercises in common real-life situations.	3	3
			Total	**26**

Self-Learning:
1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment:
ISE: ISE activities carry 100 marks. These activities will be conducted throughout the semester.

Recommended Books:
1. U.P. Upadhyaya and N.K. Krishnamurthy, Conversational Kannada, Prism Books, 2018.
2. Thomas Hodson, Grammar of the Kannada or Canarese Language, Gyan Publishing House, 2020.
3. Ramanja Reddy Merugu, Learn Kannada Through English, 2021.

Suggested CO - PO Articulation Matrix

Course Outcomes	Programme Outcomes (POs)										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1									2		1
CO2								1	3		1
CO3								2	3		1

Legends: - High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms level

Remember	Understand	Apply ✓	Analyze	Evaluate	Create

Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25AEC12CS024	Tamil for Beginners	2	--	--	2	2	--	--	2
		Examination Scheme							
			ISE			MSE	ESE	Total	
		Theory	100		--	--	--	100	
		Lab	--		--	--	--	--	

Pre-requisite Course Codes		--
After the successful completion students should be able to:		
Course Outcomes	CO1	Recognize Tamil alphabets and read simple Tamil words with correct pronunciation.
	CO2	Construct simple Tamil sentences using basic grammar and vocabulary.
	CO3	Interact in Tamil using short conversations in everyday situations.

Module No.	Unit No.	Topics	Ref.	Hrs.
1	**Tamil Script, Reading and Basic Spoken Expressions**			
	1.1	**Introduction to Tamil Script and Sounds:** Tamil language and script characteristics. Tamil vowels and consonants. Formation of simple words.	1	2
	1.2	**Reading Practice:** Reading simple Tamil words. Practice of letters and words. Pronunciation exercises.	1	3
	1.3	**Basic Spoken Expressions:** Greetings, self-introduction and simple questions. Polite expressions used in communication.	1	3
2	**Basic Tamil Grammar and Sentence Construction**			
	2.1	**Basic Sentence Construction:** Formation of simple sentences. Question forms and responses. Use of common verbs.	2	3
	2.2	**Functional Grammar:** Use of tenses in simple sentences. Use of adjectives and adverbs. Negative and interrogative sentences.	2	3
3	**Vocabulary Development and Practical Expressions**			
	3.1	**Everyday Vocabulary:** Numbers and counting. Time expressions. Words related to home and college environment.	3	3
	3.2	**Practical Expressions:** Asking directions. Buying items. Using public transport. Simple telephone conversations.	3	3
4	**Applied Conversation and Interactive Language Practice**			
	4.1	**Interactive Language Activities:** Dialogue practice. Listening exercises. Group speaking activities.	3	3
	4.2	**Situational Communication Practice:** Conversations in everyday situations. Speaking practice for requesting information and giving responses. Simple dialogues for travel and public services. Listening and response exercises.	1	3
			Total	**26**

Self-Learning:
1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment:

ISE: ISE activities carry 100 marks. These activities will be conducted throughout the semester.

Recommended Books:

1. E. Annamalai, *Colloquial Tamil: The Complete Course for Beginners*, Routledge Publications.
2. Harold F. Schiffman, *A Reference Grammar of Spoken Tamil*, Cambridge University Press.
3. N. S. Ramaswami, *Learn Tamil Through English*, New Century Book House.

Suggested CO - PO Articulation Matrix

Course Outcomes	Programme Outcomes (POs)										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1									2		1
CO2								1	3		1
CO3								2	3		1

Legends :- High: 03, Medium: 02,Low: 01, No Mapping: -

Blooms level

Remember	Understand	Apply ✓	Analyze	Evaluate	Create

Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25VEC12CS01	Human Values and Professional Ethics	1	--	2	1	1	--	1	2
			Examination Scheme						
			ISE			MSE	ESE		Total
		Lab	100	---		--	---		100

Pre-requisite Course Codes		--
After the successful completion students should be able to:		
Course Outcomes	CO1	Adhere to the core rights and shape one's values.
	CO2	Display the role and responsibility of Engineering professionals.
	CO3	Holds moral and Ethical solutions to problems through case studies.
	CO4	Apply the knowledge of human values to contemporary ethical and global issues.

Module No.	Exp. No.	Topics	Ref.	Hrs.
1		**Background and Approach: Fundamental Rights and Duties**		
	1.1	Fundamental Rights and Duties, Right to Compensation for being Illegally Deprived of one's Right to Life or Liberty, Right to Travel Abroad and Return to one's Country	1,2	2
	1.2	Promotion of Inter-Religious harmony and inter-faith values, Composite Culture	1,2,3	1
2	2	**Professional Ethics and Human Values**		
	2.1	Sense of Engineering Ethics - Variety of moral issues- Types of inquiry- Moral dilemmas –Moral Autonomy Moral dilemmas, Moral Autonomy, Kohlberg's theory Gilligan's theory, Consensus and Controversy, Profession& Professionalism, Models of professional roles, Theories about right action Codes of Ethics, Plagiarism	3,4	3
	2.2	Human Values. Morals, values, and Ethics – Integrity- Academic integrity- Work Ethics- Service Learning- Civic Virtue Respect for others- Living peacefully- Caring and Sharing- Honestly- Cooperation Commitment Empathy-Self Confidence -Social Expectations.	1,2,3	2
	2.3	Managing conflict- Respect for authority- Collective bargaining- Confidentiality, Role of confidentiality in moral integrity- Conflicts of interest	3,4	2
3		**Global Ethical Concerns**		
	3.1	Multinational Corporations- Environmental Ethics- Business Ethics- Computer Ethics	2,3,4	2
	3.2	Engineers as Expert witnesses and advisors-Moral leadership- case studies	1,2,3 ,4	1
			Total	**13**

Self-Learning:
1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment:

ISE: ISE activities carry 100 marks. These activities will be conducted throughout the semester.

Recommended Books:

1. Mike W Martin and Roland Schinzinger, Ethics in Engineering,4th edition, Tata McGraw Hill Publishing Company Pvt Ltd, New Delhi,2014.
2. Charles D Fleddermann, Engineering Ethics, Pearson Education/ Prentice Hall of India, New Jersey,2004.
3. Charles E Harris, Michael S Protchard and Michael J Rabins, Engineering Ethics-Concepts and cases, Wadsworth Thompson Learning, United States,2005.
4. M Govindarajan, S Natarajan and V S Senthil Kumar, Engineering Ethics, PHI Learning Private Ltd, New Delhi,2012.
5. R S Naagarazan, A textbook on professional ethics and human values, New Age International (P) limited,New Delhi,2006.

Online Repository:

1. Human Values and Professional Ethics by Udemy
2. Workplace Ethics and Professionalism by Coursera
3. Global Impact: Business Ethics by Coursera
4. Human Values and Professional Ethics by SWAYAM

Suggested CO - PO Articulation Matrix

Course Outcomes	Programme Outcomes (POs)										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1							3	2	2		2
CO2						2	3	2	2		2
CO3						2	3	2	2		2
CO4							3	2	2		2

Legends :- High: 03, Medium: 02,Low: 01, No Mapping: -

Blooms level

Remember	Understand	Apply ✓	Analyze	Evaluate	Create

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
25CEP12CS01	Community Engagement Project	L	T	P	L	T	P	Total
		--	--	4	--	--	2	2
		Examination Scheme						
			ISE		MSE	ESE	Total	
		Theory	--		--	--	--	
		Lab	100		--	--	100	

Pre-requisite Course Codes		--
After the successful completion students should be able to:		
Course Outcomes	CO1	Identify and address community needs and challenges which help learners to develop problem-solving skills and creativity in finding innovative solutions.
	CO2	Enhance their cultural competence and ability to work effectively in multicultural settings
	CO3	Critically think on complex issues considering multiple view points
	CO4	Demonstrate collaboration, team work, civic engagement, empathy and compassion while engaging directly with community
	CO5	Develop a lifelong commitment to social justice and making a positive impact in the world

This course requires students to participate in field-based learning/projects generally under the supervision of faculty. The curricular component of 'community engagement and service' involve activities that would expose students to the socio-economic issues in society so that the theoretical learnings can be supplemented by actual life experiences to generate solutions to real-life problems.

At the end of the course, it is expected that students will have valuable learnings in terms of enhanced communication skills, increased cultural competence, improved critical thinking, leadership skills, collaboration skills, empathy & compassion, civic engagement, problem-solving skills, self-reflection & personal growth and long-term commitment to social justice.

It is expected that 26-30 hours of contact time per credit in a semester (52 to 60 hours in a semester for 2 credits) along with 13-15 hours of activities such as preparation for community engagement and service, preparation of reports, etc., and independent reading and study.

Other Guidelines to students for successful Community Engagement:

Community engagement is the process of working collaboratively with and through groups of people affiliated by geographic proximity, special interest, or similar situations to address issues affecting the well-being of those people It is a powerful vehicle for bringing about environmental and behavioral changes that will improve the health of the community and its members. It often involves partnerships and coalitions that help mobilize resources and influence systems, change relationships among partners, and serve as catalysts for changing policies, programs, and practices.

Community engagement project is different as compared to traditional consultation. It is a regular engagement of community for achieving an identified goal or vision. It recognizes the role of community engagement in its broadest sense in the development of local democracy, while noting that the focus of the report is on the practice of community engagement as it relates to local authority activity.

Communication, diplomacy, patience, and flexibility are essential to engage with a community. For a successful engagement, conditions include shared and defined purpose. Willingness to collaborate. Commitment to contributing. Participation of the right people. Open and credible process. Involvement of a champion with credibility and clout. Ensure that the engagement process is complex but manageable. Initially the team will: Discuss and define the initiative and its potential impact. Set the purpose and goals for community engagement. Define the community. Know and respect the community's characteristics. Develop a relationship with the community, build trust, work with formal and informal leadership, find the community gatekeeper, identify the project champion, meet with the local organizations, and learn the assets and challenges for that community. Find the common interests.

The following four phases provide broad outline for the community engagement process:

Phase-I: Outreach

Go to the community instead of having the community come to you. Invite the stakeholders to a conversation. Create a constructive environment for dialogue allowing time to get to know the participants remembering that the community's time is valuable and must be respected. Identify the person or the organization that has convened the group and will provide initial leadership and organizational management. Outline the purpose and process for the conversation. Use a facilitator when appropriate. Define the issue and why it is important. Outline what is broken and focus on what is working. Is the issue a people problem or a situation problem? Can the problem be solved with technical expertise or will it require something else? Determine the interest and merit in hosting future discussions.

Phase-II: Gather Facts, Brainstorm and Select

Create an environment for discussion where people are comfortable asking questions, expressing doubts, and brainstorming new ideas. Gather the facts related to the issue and its impact. Use a SWOT, appreciative inquire, asset mapping, and other tools during the factfinding stage. Clarify the issue's alignment with the community's values and ethics. Establish the common ground on which conversations will be based. Brainstorm and gather alternative solutions. Ask the "what if" questions. Spend time discussing the options and the potential impact. Allow the process to equip the participants to see the change, feel the change, and then be prepared to change. Select the best practice/solution. If required use decision-making tools to reduce the number of options.

Phase-III: Plan and Review

Write the implementation action plan. Include the evaluation procedure that will answer the question "What will it look like when the change has happened?". Discuss the proposal with the appropriate stakeholders searching for insight and response. Use the feedback to assess and revise the plan. Stay focused on the solution.

Phase-IV: Implement and Evaluate

Implement the plan. Remember, groups want a rapid success. Identify an action that will provide a "meaningful win" within the "immediate reach." Evaluate the impact. Report the status to the community and gather feedback. Revise the plan and evaluate again.

Keep the participants informed through discussion agendas, written summaries of previous discussions, goals/assignments for the next discussion, and progress reports providing accountability for delivering what was promised.

Course Assessment:

ISE: ISE activities carry 100 marks. These activities will be conducted throughout the semester.

Activity: Report Submission: 20 Marks
Activity: Report Presentation: 30 Marks

Activity: Report Submission: 20 Marks
Activity: Report Presentation: 30 Marks

Suggested CO - PO Articulation Matrix

Course Outcomes	Programme Outcomes (POs)										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	3	2		3	3	2	2	2	
CO2	2	2	2			3	2	3	2	3	
CO3	3	3	2	2		2		2	2	2	
CO4	2	2	3	2		3	2	3	3	3	2
CO5	2	2	3	2		3	2	3	3	2	2

Legends: - High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms level

Remember	Understand	Apply ✓	Analyze ✓	Evaluate ✓	Create

Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25BSC12CS06	Linear Algebra and Business Statistics	2	1	--	3	2	1	--	3
		Examination Scheme							
			ISE			MSE	ESE	Total	
		Theory	20			30	50	100	
		Tut	50			--	--	50	

Pre-requisite Course Codes		--
After the successful completion students should be able to:		
Course Outcomes	CO1	Explain the fundamental concepts of vector spaces as algebraic structures.
	CO2	Solve linear programming problems to optimize objective functions under given constraints.
	CO3	Apply non-linear programming techniques to optimize objective functions subject to constraints.
	CO4	Apply non-parametric tests such as the Sign Test and Wilcoxon Signed-Rank Test to analyse sample data and test hypotheses.

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Linear Algebra – Vector Spaces**		
	1.1	Introduction to Vector Spaces	1,2	2
	1.2	Subspaces of vector spaces	1,2	2
	1.3	Basis and dimension	1,2	1
	1.4	The Gram-Schmidt orthogonalization process	1,2	1
2		**Linear programming Problems (LPP)**		
	2.1	Types of solutions, Standard and Canonical of LPP, Basic and Feasible solutions, Slack variables, Surplus variables, Simplex Method.	3,4,5,6	3
	2.2	Artificial variables, Big-M method (Method of penalty)	3,4,5,6	2
	2.3	Duality, Dual of LPP and Dual Simplex Method	3,4,5,6	2
3		**Non-linear Programming Problems (NLPP)**		
	3.1	NLPP with one equality constraint (two or three variables) using Lagrange's multiplier method	3,4,5,6	2
	3.2	NLPP with two equality constraints	3,4,5,6	2
	3.3	NLPP with inequality constraint: Kuhn-Tucker conditions	3,4,5,6	2
4		**Correlation and Non-parametric Methods**		
	4.1	Karl Pearson's Coefficient of correlation (r) and related concepts with problems.	3,4,7	2
	4.2	Spearman's Rank correlation coefficient (R) (Repeated & non repeated ranks problems)	3,4,7	1
	4.3	Sign Test: Hypothesis test about a population median	3,4,7	2

	4.4	Wilcoxon signed-rank test (analysing data from a matched-sample experiment), Mann–Whitney U Test	3,4,7	2
			Total	**26**

Self-Learning:
1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment:

Theory:

ISE: ISE activities carry 20 marks. These activities will be conducted throughout the semester.
MSE: The written summative examination of 30 marks based on 50% syllabus for 90 minutes.
ESE: The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes

Tutorials: Assignments to be completed on Journal Paper			
	Topics	**Ref.**	**Hrs.**
1	Vector Spaces and Subspaces Problem solving on verifying algebraic structure as vector spaces. Identifying subspaces of a vector space.	1,2	1
2	Basis and Dimension, Gram-Schmidt Orthogonalisation Process Problem solving on finding the basis and dimension of a vector space/subspace. Extend the basis to orthogonal and orthonormal basis by using Gram-Schmidt Orthogonalisation Process	1,2	1
3	Problem solving include standard form of LPP, Simplex method and Big-M method.	3,4,5,6	1
4	Problem solving on Canonical form of LPP, Duality and Dual simplex method.	3,4,5,6	1
5	Problem solving include NLPP Optimisation without any constraints, Lagrange method (NLPP optimisation with equality constraints)	3,4,5,6	1
6	Problem solving include NLPP optimisation with inequality constraints (Kuhn-Tucker method).	3,4,5,6	1
7	Problem solving on correlation coefficient and rank correlation.	3,4,7	1
8	Problem solving on Sign test, Wilcoxon signed-rank test	3,4,7	1
		Total	**8**

Course Assessment: - (Tutorial)

ISE: Formative assessment based on the tutorial assignments for 50 marks.

Recommended Books:

1. Robert M. Thrall, Leonard Tornheim, "Vector Spaces and Matrices", Dover Publications, Inc.
2. Gilbert Strang, "Linear Algebra for Everyone", Wellesley Publisher.
3. H. K. Dass, "Advanced Engineering Mathematics", S. Chand, 28th Edition.
4. Erwin Kreysizg, "Advanced Engineering Mathematics", John Wiley & Sons, 10th Edition.
5. J.K. Sharma, "Operations Research: Theory and Applications", Trinity Press (An imprint of Laxmi Publications Private Ltd.), 6th Edition.
6. P. Rama Murthy, "Operations Research", New Age International Publishers, Second Edition.
7. D.R. Anderson, D.J. Sweeney, T.J Williams, "Statistics for Business and Economics", South-Western, Cengage Learning Publication, 11th Edition.

Online Repository:

1. https://www.youtube.com/watch?v=C4slZ4jR6k4
2. https://www.youtube.com/watch?v=a2QgdDk4Xjw&list=PLjc8ejfjpgTf0LaDEHgLB3gCHZYcNtsoX
3. https://www.youtube.com/watch?v=RYqBnxL8Lbg&list=PLq-Gm0yRYwTipntZ17qTnGYAkyOPuhNEf
4. https://www.youtube.com/watch?v=MHrDKdk9hw0&list=PLp6ek2hDcoNBWXfYShSOoR6_T2vQtt8zY

Suggested CO - PO Articulation Matrix

Course Outcomes	Programme Outcomes (POs)										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2									
CO2	3	2									
CO3	3	2									
CO4	3	2									

Legends: - High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms level

Remember	Understand	Apply ✓	Analyze ✓	Evaluate	Create

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
25PCC12CS08	Computer Organization and Architecture	L	T	P	L	T	P	Total
		2	-	-	2	-	-	2
		Examination Scheme						
			ISE		MSE	ESE		Total
		Theory	20		30	50		100
		Practical	--		--	--		--

Pre-requisite Course Codes		Digital Electronics, Programming Fundamentals
Course Outcomes	Learners will be able to	
	CO1	Describe the basic structure of computer and compare architecture models.
	CO2	Implement algorithms for arithmetic operations.
	CO3	Comprehend processor architecture with various design methods of CPU.
	CO4	Classify different types of memory and implement various mapping techniques for cache and virtual memory.
	CO5	Describe I/O organization and analyze different parallel processing and pipelining concepts.
	CO6	Compare GPU and CPU architectures.

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Overview of Computer Organization and Architecture**	1	02
	1.1	Introduction of Computer Organization and Architecture, Basic organization of Computer and block level description of the functional units, Von Neumann model, Harvard model, Evolution of Intel processors.		
	1.2	Performance: Processor clock, basic performance equation, complier, performance measurement, Multiprocessor& Multicomputer, Multicore architecture.		
2		**Data Representation and Arithmetic Algorithms**	2,3	03
	2.1	Number representation: Floating point representation, floating point arithmetic, IEEE754floatingpoint number representation, Fast multiplication: Bit pair recording of multipliers		
	2.2	Booth's algorithm for signed multiplication, Restoring and Non-restoring Division		
3		**Processor Organization and Control Unit design**	1,2	06
	3.1	CPU Architecture, Register Organization, Instruction formats, basic instruction cycle, instruction interpretation and sequencing. Case study of 8086 architecture and Register organization		

	3.2	Control unit: Micro programmed and Hardwired Control unit design methods, Microinstruction sequencing and execution, micro-operations		
	3.3	Introduction to RISC and CISC architectures and design issues.		
4		**Memory Organization**	1,2,4	06
	4.1	Memory Systems: Types of memory: RAM, ROM, Cache Memory hierarchy and its importance, Cache organization and principles, mapping techniques.		
	4.2	Virtual Memory: Paging and segmentation, Page tables and translation lookaside buffers (TLBs), Memory management unit (MMU), page replacement policies.		
5		**I/O Organization and Introduction to Parallel Processing**	1,2,4	07
	5.1	Buses: Synchronous, Asynchronous, Interface circuits: Parallel port, Serial port, Standard I/O Interfaces: PCI, SCSI, USB, CAN bus		
	5.2	Parallelism in Computer Architecture: Pipelining and its advantages, pipelining stages and pipelining hazards Superscalar and VLIW architectures, SIMD and MIMD architectures		
6		**General-Purpose Graphic Processing Units**	5,6,7	02
	6.1	CUDA Basics, GPU vs CPU,GPU Architecture Overview Intel's Gen8 GPU 725		
			Total	**26**

Self-Learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.

2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment:

Theory:

ISE: ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE: The written summative examination of 30 marks based on 50% syllabus for 90 minutes..

ESE: The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Recommended Books:

1.CarlHamacher, Zvonko Vranesic, Safwat Zaky,"Computer Organization",TataMcGraw-Hill,5th Edition

2.William Stallings,"Computer Organization and Architecture,Pearson,8th Edition.

3. Morris Mano,"Computer System Architecture",Pearson,3rd Edition.

4.John P.Hayes,"Computer Architecture and Organization",Tata McGraw-Hill,3rd Edition.

SUGGESTED CO - PO articulation Matrix

Course Outcomes	Programme Outcomes (POs)											Programme Specific Outcomes* (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3											2	-	-
CO2	3	2			2							2	-	-
CO3	3	2	2									2	-	-
CO4	3	2			2							2	-	-
CO5	3	2	2		2							2	-	-
CO6		3	2					3	3		3	2	-	-

Legends:- High: 03, Medium: 02,Low: 01, No Mapping: -

Blooms level

Remember	Understand	Apply ✓	Analyze ✓	Evaluate	Create

Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25PCC12CS05	Analysis of Algorithms	2	--	2	2	2	--	1	3
		Examination Scheme							
			ISE			MSE	ESE	Total	
		Theory	20			30	50	100	
		Lab	50			--	--	50	

Pre-requisite Course Codes		Programming Fundamentals
After the successful completion students should be able to:		
Course Outcomes	CO1	Analyze the time and space complexity of algorithms.
	CO2	Apply divide and conquer strategy to solve a problem.
	CO3	Apply greedy strategy to solve optimization problem.
	CO4	Apply dynamic programming strategy to solve optimization problem.
	CO5	Apply backtracking and branch and bound strategies to solve a problem.
	CO6	Apply various string-matching algorithms to solve pattern matching problems

Module No.	Unit No.	Topics	Ref.	Hrs.
1	1.1	**Introduction:** Performance analysis, space and time complexity calculations, Asymptotic notations. Complexity class: Solving Recurrence equations using Substitution, Recursion tree and Masters theorem	1,2	7
	1.2	**Divide and Conquer strategy:** General Concept, Quick sort, Merge sort, multiplying long Integers OR Finding minimum and maximum element of an array		
2	2.1	**Greedy Strategy:** General concept, Minimum Coin Change problem, Activity Selection problem. Fractional Knapsack Problem, Minimum Spanning Tree (Prim's and Kruskal's Algorithm), Dijkstra's Algorithm	1,2	4
3	3.1	**Dynamic Programming**: General Method, 0/1 knapsack problem, longest common subsequence, Bellman ford algorithm, Floyd Warshall algorithm, Multistage Graph, Assembly line scheduling	1,2	6
4	4.1	**Backtracking and Branch and bound:** Backtracking: General Method, N-queen problem, Graph coloring Problem, Sum of subsets Branch and Bound: Travelling Salesperson Problem, 15 Puzzle problem	1,2	6
5	5.1	**String Matching Algorithms:** The Naive string-matching algorithm, The Rabin Karp algorithm, The Knuth-Morris-Pratt algorithm	1,2	3
			Total	**26**

Self-Learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.

2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment:

Theory:

ISE: ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE: The written summative examination of 30 marks based on 50% syllabus for 90 minutes

ESE: The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

To be Taught in laboratory			
Sr. No.	**Topics**	**Ref.**	**Hrs.**
1	Sorting: Implement and analyze time and space complexity of Modified bubble, Insertion and Selection sort to display exam result of students based on their total marks scored.	1,2	4
2	Divide and Conquer: Implement and analyze time and space complexity of Quick and Merge sort to display records of an employee working in any organization based on their work experience.	1,2,4	2
3	Divide and Conquer: (Any one) I. Implement and Analyze time and space complexity of multiplying long Integers using divide and conquer strategy. II. Implement and Analyze time and space complexity of finding minimum and maximum element of an array using divide and conquer strategy	1,4	2
4	Greedy Strategy: I. Identify and implement an algorithm to be used to solve the challenge faced by airline and shipping companies of maximizing revenue while adhering to weight and space constraints when loading cargo onto airplanes or ships. Determine the optimal selection and allocation of cargo items based on their values (revenue) and weights, ensuring efficient use of cargo space. II. Identify and implement an algorithm to be used in the construction of communication networks (telephone or internet networks) where a telecommunication company needs to lay down cables to connect several cities to establish a renetwork infrastructure. The company wants to minimize the cost of laying down cables while ensuring that all cities are connected and there is no redundancy in the network.	1,3,4	6

	III. Identify and implement an algorithm to be used by vending machines to determine the optimal combination of coins to give as change to customers.		
5	Dynamic Programming: I. Identify and implement an algorithm to be used in disaster management and emergency response systems to find the shortest path for emergency vehicles, such as ambulances or fire trucks, to reach affected areas or victims. II. Identify and implement an algorithm to be used to compare DNA /RNA sequences to identify similarities and evolutionary relationships between organisms. III. Identify and implement an algorithm to be used by city planners and urban developers to determine the shortest paths between all pairs of locations, such as residential areas, commercial centers, and public facilities, to improve accessibility, reduce traffic congestion, and enhance urban mobility.	1,4	6
6	Backtracking: I. Implement N queen problem II. Identify and implement an algorithm to be used for coloring regions on a map such that adjacent regions do not have same color.	1,3	4
7	String Matching: Identify and implement an algorithm to be used by search engines to quickly locate documents containing specific keywords or phrases, improving search efficiency and response time.	1,4	2
		Total	**26**

Course Assessment: - (Lab)

ISE: Laboratory ISE is divided into two components: 25 marks for submission of experiments and 25 marks for oral/practical evaluation.

Recommended Books:

1. T. H. Cormen, C.E. Leiserson, R. L. Rivest, and C. Stein, "Introduction to algorithms", 2nd Edition, PHI Publication 2005.
2. Ellis Horowitz, Sartaj Sahni, S. Rajsekaran. "Fundamentals of computer algorithms"University Press
3. Steven S. Skiena , "Algorithm Design Manual", Springer Publication
4. Sanjoy Dasgupta, Christos Papadimitriou, Umesh Vazirani, "Algorithms", Tata McGraw Hill Edition
5. S. K. Basu, "Design Methods and Analysis of Algorithm", PHI

Online Repository:

1. https://nptel.ac.in/courses/106/106/106106131/
2. https://www.coursera.org/specializations/algorithms
3. https://www.mooc-list.com/tags/algorithms
4. https://www.youtube.com/watch?v=aGjL7YXI31Q&list=PLEbnTDJUr_IeHYw_sfBOJ6gk5pi e0yP-0
5. https://www.geeksforgeeks.org/design-and-analysis-of-algorithms/
6. Algorithm visualization tool https://visualgo.net/

7. LeetCode/ HackerRank platform to solve challenging problems

Suggested CO - PO Articulation Matrix

Course Outcomes	Programme Outcomes (POs)										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	2								
CO2	3	3	2								
CO3	3	3	2								
CO4	3	3	2								
CO5	3	3	2								
CO6	3	2	2								

Legends: - High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms level

Remember	Understand	Apply ✓	Analyze ✓	Evaluate	Create

Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
		2	-	2	2	2	-	1	3
25PCC12CS10	Data Analytics and Visualization	Examination Scheme							
			ISE			MSE	ESE	Total	
		Theory	20			30	50	100	
		Practical	50			--	--	50	

Pre-requisite Course Codes		Discrete Maths, Statistics
Course Outcomes	CO1	Perform Exploratory Data Analysis (EDA) on structured datasets using statistical summaries and visualization techniques to identify patterns, trends, and anomalies.
	CO2	Apply appropriate data visualization techniques using modern analytical tools to represent real-world data effectively and support decision-making.
	CO3	Develop and interpret regression models to perform prediction and evaluate model performance using suitable metrics.
	CO4	Analyze time series data using decomposition, forecasting methods, and trend analysis techniques.
	CO5	Evaluate text analytics models using appropriate methods to derive meaningful insights from textual data.

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Introduction**	1,2	4
	1.1	Data Analytics Lifecycle overview: Key Roles for a Successful Analytics, Background and Overview of Data Analytics Lifecycle Project		
	1.2	Need of exploratory data analysis, Understand the Data, Data Collection, Data Cleaning, Data Transformation, Data Integration, Data Exploration, Data Summarization, Feature engineering, the Kinds of Data Analytics – Descriptive, Diagnostic, Predictive and Data Mining		
2		**Data Visualization**	2	4
	2.1	Principles of effective visualization, Benefits of Visualization. Types of visualizations: **Charts**: Bar charts, line charts, pie charts, etc. **Graphs**: Scatter plots, histograms, boxplot, word cloud etc. **Maps**: Geographic maps, heat maps etc. **Dashboards**: Interactive platforms that combine multiple visualizations. Data Visualization Tools: Excel, Tableau, Power BI		
3		**Regression**	2,5	6
	3.1	Introduction to simple Linear Regression: The Regression Equation, fitted value and Residuals, Least Square Method,		

		Coefficient of Determination, Correlation Coefficient, Regression coefficient Introduction to Multiple Linear Regression: Assessing the Model, Cross-Validation, Model Selection and Stepwise Regression, Prediction Using Regression		
	3.2	Logistic Regression: Logistic Response function and logit, Logistic Regression and GLM, Generalized Linear model, predicted values from Logistic Regression, Interpreting the coefficients and odds ratios, Linear and Logistic Regression: similarities and Differences, Assessing the models.		
4		**Time Series Analysis and Prediction**	1,3	6
	4.1	Overview of Time Series Analysis, Components of time series, decomposition of time series, methods of finding trend, methods of finding seasonal variation, Additive model, Multiplicative model, Box-Jenkins Methodology		
	4.2	Autoregressive Models, Moving Average Models, ARMA and ARIMA Models, SARIMA models, Autocorrelation Function, Partial autocorrelation function (ACF, PACF), Building and Evaluating an ARIMA Model,		
5		**Text Analytics**	1,4	6
	5.1	History of text mining, Roots of text mining, overview of seven practices of text analytic, Application and use cases for Text mining: extracting meaning from unstructured text, Summarizing Text.		
	5.2	Text Analysis Steps, A Text Analysis Example, Collecting Raw Text, Representing Text, Term Frequency—Inverse Document Frequency (TFIDF), Categorizing Documents by Topics, Determining Sentiments, Gaining Insights.		
			Total	**26**

Self-Learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.

2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment:

Theory:

ISE: ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE: The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE: The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes

Lab:

ISE: Laboratory ISE is divided into two components: 25 marks for submission of experiments and 25 marks for oral/practical evaluation.

Module No.	Exp. No.	Suggested List of experiments
1	1	Install data analysis and visualization tools: python/ Tableau public/ power BI and Perform exploratory analysis on any real-world data using python
2	2	a. Implement data visualization using excel b. Implement data visualization in python
2	3	a. Performing Data Analysis and representation on a Map using various Map data sets with Mouse Rollover effect, user interaction, etc., b. Build cartographic visualization for multiple datasets
3	4	a. Apply Linear regression to given data set b. Apply Logistic regression to given data set
4	5	Implement time series decomposition
4	6	Build a time-series model (ARIMA) on a given dataset and evaluate its accuracy
5	7	a. Perform text mining on a set of documents and visualize the most important words in a visualization such as word cloud. b. Implement TFIDF algorithm c. Perform text sentiment analysis
	8	Build interactive application (dashboard, storytelling etc.) using Tableau

Recommended Books:

1. Wes McKinney, "Python for Data Analysis", 3rd Edition, Publisher(s): O'Reilly Media, Inc.
2. Bharati Motwani, "Data Analytics using Python", 2nd Edition, Wiley Publications
3. George Athanasopoulos, Rob J Hyndman, "Forecasting: Principles and Practice", 3rd Edition, Otext Publication
4. Dipanjan Sarkar, "Text Analytics with Python: A Practitioner's Guide to Natural Language Processing", 2ND EDITION, Apress publisher
5. David R. Anderson, Dennis J. Sweeney, Thomas A. Williams, "Statistics for Business and Economics"11th Edition, South-Western, Cengage Learning

Online Repository:

1. https://www.kaggle.com/learn
2. https://www.datascience-pm.com/crisp-dm-2/
3. https://www.tableau.com/learn/training
4. https://learn.microsoft.com/en-us/training/powerplatform/power-bi
5. https://scikit-learn.org/stable/
6. https://otexts.com/fpp3/

7. https://github.com/dipanjanS/text-analytics-with-python

Suggested CO - PO Articulation Matrix

Course Outcomes	Programme Outcomes (POs)										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	2	2	2						
CO2	2	2	3	2	3					2	
CO3	3	3	3	3	2						
CO4	3	3	2	3	2						
CO5	2	3	2	2	2			2			

Legends: - High: 03, Medium: 02,Low: 01, No Mapping: -

Blooms level

Remember	Understand	**Apply ✓**	**Analyse ✓**	**Evaluate ✓**	Create

Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25PCC12CS11	Competitive Coding Lab	--	--	2	--		--	1	1
		Examination Scheme							
			ISE			MSE	ESE	Total	
		Theory	--			--	--	--	
		Lab	50			--	--	50	

Pre-requisite Course Codes		Programming Fundamentals, Data structure, Analysis of algorithm, Programming Language C/C++/ Java
After the successful completion students should be able to:		
Course Outcomes	CO1	Solve advanced array and string problems using efficient techniques like the sliding window and two-pointer approach.
	CO2	Develop expertise in utilizing linked lists, stacks, and queues to efficiently solve complex computational problems.
	CO3	Apply graph and tree algorithms to solve complex problems, enhancing data analysis and optimization efficiency.
	CO4	Implement efficient pattern-matching algorithms, optimizing performance through detailed complexity analysis.
	CO5	Apply bit manipulation, number theory, and modular arithmetic techniques to effectively solve real-world computational problems.

To be Taught in laboratory			
	Topics wise List of Experiments with relevant topic	**Ref.**	**COs**
1	**Complexity Classes & Algorithm Comparison:** Revise and compare algorithms based on the following time complexities: • O(1): Constant time - e.g., accessing an array element • O(log n): Logarithmic time - e.g., binary search • O(√n): Square root time - e.g., algorithms involving geometric operations • O(n): Linear time - e.g., linear search • O(n log n): Linearithmic time - e.g., merge sort, quick sort, heap sort • $O(n^2)$: Quadratic time - e.g., bubble sort, insertion sort • $O(n^3)$: Cubic time - e.g., 3D matrix operations • $O(2^n)$: Exponential time - e.g., brute-force for the Traveling Salesman Problem • O(n!): Factorial time - e.g., generating all permutations	3	--
2	**Advanced Standard Library Data Structures** Deepen your understanding of dynamic arrays, sets, maps, iterators, and range operations with real-world applications and optimization challenges: • **Dynamic Arrays:** Implement efficient resizing and compare performance across insertions and deletions.	3	CO1

	• **Sets & Maps:** Solve problems with custom comparisons, such as finding the top K elements or first unique character in a stream. • **Iterators & Range Operations:** Use iterators for merging sorted arrays or sliding window algorithms with range queries. • **Optimized Data Structures:** Implement custom map/set from scratch, optimizing for time and memory complexity. **Lab Exercise:** • Given a string s, find the index of the first non-repeating character in it. If it does not exist, return -1. • Find the top K elements dynamically with maps and sets. • Solve the sliding window maximum problem with efficient complexity using range-based operations. • Happy Number: A number n is *happy* if this process terminates in 1: Replace n with the sum of the squares of its digits. Repeat until n equals 1 (happy) or a loop appears (unhappy).		
3	**Advanced Arrays and Strings:** Learn and apply techniques like the sliding window, two-pointer approach, and binary search to solve complex problems in arrays and strings. **Lab Exercises:** • Find the maximum sum sub-array of size K using the sliding window technique. • Find the longest substring without repeating characters. • Find a pair with a given sum in a sorted array using the two-pointer technique. • Search for an element in a rotated sorted array using binary search. • Check if there is a pair in an array with a given sum X using hashing. • Find the first missing positive integer in an unsorted array. • Find the maximum product of two integers in an array. • Find the longest increasing subsequence in an unsorted array. **Advanced Learner Challenges:** • Count all palindromic substrings in a given string. • Find the minimum number of swaps required to make a string palindrome. • Solve the "Longest Palindromic Substring" problem using Manacher's algorithm. • Sort an array and count the number of inversions. • Find the median of two sorted arrays using binary search. • Solve the "Kth Largest Element in an Array" using the quick-select algorithm. • Find all unique triplets in an array that sum to zero. • Solve the "Container With Most Water" problem using the two-pointer approach. • Implement a solution for the "3Sum" problem using sorting and two-pointer technique.	3	CO1
4	**Linked List:**	3	CO2

	Study the fundamental operations and advanced techniques involving linked lists, including reversing, detecting loops, and rearranging nodes. **Lab Exercises:** • Merge two sorted linked lists into one sorted list. • Detect if a linked list is a palindrome using two-pointer technique. • Find the middle element of a linked list using two pointers. • Remove Nth node form end of a linkedlist. • Swap every two adjacent nodes and return its head. • Remove duplicates in a sorted linked list. • Reverse a linked list in groups of K. • Detect and remove a loop in a linked list. • Merge k Sorted Lists • Implement an LRU cache using doubly linked list and hash map. **Advanced Learner Challenges:** • Flatten a multilevel doubly linked list (where each node may have a next and child pointer). • Find the intersection point of two linked lists using optimized space (no additional data structures). • Merge k sorted linked lists using a priority queue. • Detect and handle cycle in a linked list using the Floyd's cycle-finding algorithm (Tortoise and Hare). • Implement a doubly linked list and perform operations like insertion, deletion, and traversal.		
5	**Stack and Queue:** Study the fundamental operations of stacks and queues, including their applications and efficient implementations. **Lab Exercises:** • Sort a stack using recursion. • Check for balanced parentheses using a stack. • Implement a circular queue using arrays or linked lists. • Generate binary numbers from 1 to N using a queue. • Implement a queue using two stacks. • Reverse a stack using recursion. • Implement a stack using linked list and perform basic operations. • Implement a queue using two stacks and perform enqueue and dequeue operations. • Solve the "Next Greater Element" problem using a stack. • Implement a queue that supports fast access to both the front and back elements. • Implement a priority queue using a heap data structure. **Advanced Learner Challenges:** • Implement a stack that supports retrieving the minimum element in O(1) time. • Evaluate Reverse Polish Notation (RPN) using a stack. • Design and implement an LRU (Least Recently Used) Cache with O(1) operations for both get and put. • Solve the "Sliding Window Maximum" problem using deque.	3	CO2

	• Design a queue that supports O(1) time complexity for enqueue and dequeue operations using a doubly linked list.		
	POST MSE		
6.	**Graphs:** Study essential graph algorithms including Topological Sorting, Maximum Flow, Maximum Bipartite Matching, Strongly Connected Components, and Cycle Detection using Union-Find. **Lab Exercises:** • Detect a cycle in a graph using Depth-First Search (DFS). • Detecting cycles in undirected graphs using **Dis joint sets**. • Find all connected components in an undirected graph using DFS/BFS. • Implement the Shortest Path algorithm in an unweighted graph. • Perform Topological Sorting on a Directed Acyclic Graph (DAG). • Solve the Word Ladder problem using BFS. • Check if a graph is bipartite using BFS/DFS. • Implement Dijkstra's algorithm for the shortest path in a weighted graph. • Find the shortest path in a graph using Bellman-Ford Algorithm. **Advanced Learner Challenges:** • Find all Strongly Connected Components (SCCs) in a directed graph using Tarjan's Algorithm. • Solve the Maximum Bipartite Matching problem using augmenting paths or Hopcroft-Karp algorithm. • Implement the Ford-Fulkerson Algorithm for Maximum Flow and use Edmonds-Karp for efficient implementation. • Solve graph colouring problems with greedy or backtracking algorithms. • Apply the Hungarian Algorithm to solve the assignment problem. • Implement Minimum Spanning Tree using Kruskal's or Prim's Algorithm.	3	CO3
7	**Trees: -** Study essential tree structures such as Binary Search Trees (BST), B-Trees, AVL Trees, Red-Black Trees, Segment Trees, and Binary Index Trees, with a focus on their construction, operations, and applications. • Binary Search Tree (BST): Insert a key into a Binary Search Tree (BST), search for a key, delete a node while maintaining properties, perform inorder, preorder, and postorder traversals, find the height, check if a binary tree is a valid BST, and find the Lowest Common Ancestor (LCA) of two nodes. • B-Trees and B+ Trees: Insert keys into a B-Tree while maintaining balance, delete keys ensuring validity, and traverse all keys in sorted order in a B+ Tree. • AVL Tree: Insert a node into an AVL Tree with rotations (LL, RR, LR, RL) and check if a binary tree is height-balanced. • Red-Black Tree: Insert a key into a Red-Black Tree while maintaining properties and check if a tree satisfies Red-Black Tree rules.	3	CO3

	• Segment Trees: Construct a segment tree for range sum queries, query the sum of a range [l, r], and update an index in the array with reflected changes in the segment tree. • Binary Index Tree (BIT): Build a Binary Index Tree for prefix sum queries, query the prefix sum up to a given index, and update an element reflecting changes in the BIT. **Advanced Learner:** (Fenwick Tree, LCA with Binary Lifting, Heavy Light decomposition). • Find the Maximum Value in a Range After K Range Updates (Lazy Propagation). • Dynamic Range Sum Queries Using Fenwick Tree. • LCA of Two Nodes Using Binary Lifting. • Path Queries in a Tree Using Heavy-Light Decomposition.		
8	**Greedy Algorithms:** Study advanced interval scheduling problems and complex optimization problems using greedy techniques. **Lab Exercises:** • Implement Huffman coding for data compression. • Solve the Activity Selection Problem to choose the maximum number of compatible activities. • Find the minimum number of coins required to make a given amount (Coin Change Problem). • Solve the Fractional Knapsack Problem to maximize the total value of items in a knapsack. • Solve the Jump Game problem to determine if it's possible to reach the last index of an array. • Find the minimum number of platforms required for trains, given their arrival and departure times. • Solve the Job Sequencing Problem to schedule jobs with deadlines and maximize profit. • Maximize the sum of selected intervals by finding non-overlapping intervals. • Solve the interval covering problem to select the smallest number of intervals covering a given range. **Advanced Learner Challenges:** • Use Prim's Algorithm to find the minimum cost to connect all points in a graph (Minimum Spanning Tree). • Split an array into M subarrays to minimize the largest sum using binary search and greedy methods. • Construct the Lexicographically smallest string after K swaps. • Maximize the number of non-overlapping subarrays with a given sum using greedy algorithms. • Solve the Min-Cost to Connect All Points problem using a greedy approach and MST. • Solve the Minimum Cost to Hire K Workers problem with constraints.	3	CO3

	• Maximize the total weight of intervals in an interval scheduling problem with additional constraints.		
9	**Dynamic Programming:** Explore foundational and advanced concepts, including the Travelling Salesman Problem (TSP), Longest Arithmetic Subsequence, and various Matrix DP problems. **Lab Exercises:** • Solve the Fibonacci sequence using recursion and dynamic programming. • Implement Matrix Chain Multiplication to minimize multiplication costs. • Find the Longest Increasing Subsequence in a given array. • Solve the 0/1 Knapsack Problem using DP. • Determine if an array can be partitioned into two subsets with equal sums (Partition Equal Subset Sum). • Find the number of unique paths in an m x n grid (robot grid path problem). • Solve the Longest Common Subsequence (LCS) problem for two strings. • Compute the Edit Distance (minimum operations to convert one string to another). • Solve the Coin Change problem to find the minimum number of coins needed to make a sum. **Advanced Learner Challenges:** • Compute the Maximum Path Sum in a Binary Tree using dynamic programming. • Solve the Travelling Salesman Problem (TSP) using bit masking and DP. • Find the minimum number of insertions to make a string a palindrome. • Solve the Maximum Rectangle in a Binary Matrix problem. • Find the minimum cost path in a weighted grid using DP. • Implement Word Break Problem using a dictionary and DP.	1,4	CO3 CO1
10	**Strings and Pattern Matching:** Explore key algorithms for string matching, including Rabin-Karp, Z-Algorithm, and Knuth-Morris-Pratt (KMP). **Lab Exercises:** • Find the longest palindromic substring in a given string. • Implement the KMP pattern matching algorithm to search for a pattern in a text. • Find all occurrences of a pattern in a text using the Rabin-Karp algorithm. • Find the smallest window in a string that contains all characters of another string. **Advanced Learner Challenges:** • Compute the Longest Prefix which is also a Suffix (LPS Array) for a string.	1,4	CO4

	• Find the shortest string that contains all permutations of another string. • Generate all palindromic substrings of a string efficiently. • Implement the Z-Algorithm for pattern matching in a string		
11	**Bit Manipulation:** Master the use of bitwise operators and their applications, including subset generation, XOR tricks, subset sum with bit masking, and counting set bits. **Lab Exercises:** • Find the only non-repeating number in an array using XOR. • Compute the maximum XOR of two numbers in an array. • Count the number of set bits (1s) in an integer using bitwise operations. • Generate all subsets of a set using bit masking. • Solve the problem of checking if a number is a power of two using bit manipulation. **Advanced Learner Challenges:** • Reverse the bits of a given number. • Check if a number is a power of two using bitwise tricks. • Find the number of ways to partition a set using XOR. • Solve the Travelling Salesman Problem (TSP) using bit masking and dynamic programming.	1,4	CO5
12	**Mathematics and Number Theory:** Explore fundamental concepts in number theory, including the Chinese Remainder Theorem, tiling problems, modular arithmetic, and key algorithms such as GCD, LCM, prime factorization, and combinatorics. **Lab Exercises:** • Find the number of ways to tile a floor of size NxM using 1xM tiles. • Find the Kth smallest number in lexicographical order. • Count the number of distinct subsequence's of a string using modular arithmetic. • Solve modular arithmetic problems using basic number theory operations (GCD, LCM). **Advanced Learner Challenges:** • Use the Sieve of Eratosthenes to find all prime numbers less than N and explore its variants. • Apply the Chinese Remainder Theorem to solve modular congruence's and related problems	1,4	CO5

Course Assessment: - (Lab)

ISE: Laboratory ISE is divided into two components: 25 marks for submission of experiments and 25 marks for oral/practical evaluation.

Recommended Books:

1. The Algorithm Design Manual by Steven S. Skiena
2. Competitive Programmer's Handbook by Antti Laaksonen
3. Elements of Programming Interviews by Adnan Aziz (for interview-focused problem-solving)

Online Repository:

1. Video tutorials on competitive programming (YouTube channels like Abdul Bari, CodeChef)
2. GitHub - Competitive Programming
3. **Codeforces**: For high-level algorithmic challenges
4. **LeetCode**: For interview-specific questions
5. **HackerRank**: For implementation-heavy challenges
6. **TopCoder**: For advanced contests and problems
7. **CodeChef**: For practicing competitive programming problems and contests
8. **AtCoder**: For practicing algorithmic problems with increasing difficulty
9. **SPOJ**: For a wide variety of algorithmic challenges

Online Certification Courses:

- Udemy - The Bible of Competitive Programming & Coding Interviews
- Coursera - Data Structures and Algorithm Specialization by UC San Diego

Additional Practice:

- **Linked Lists**: Problems on LeetCode (Linked List), GeeksforGeeks (Linked List Practice)
- **Stacks**: Problems on GeeksforGeeks (Stacks), HackerRank (Stacks)
- **Queues**: Practice on HackerRank (Queues), LeetCode (Queue Problems)
- **Trees**: Explore Binary Tree problems on LeetCode, GeeksforGeeks (Binary Trees)
- **Graphs**: Problems on Codeforces (Graphs), LeetCode (Graph Problems), GeeksforGeeks (Graph Algorithms)

Suggested CO - PO Articulation Matrix

Course Outcomes	Programme Outcomes (POs)										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	3	3	2						2
CO2	3	3	3	3	2						2
CO3	3	3	3	3	2						2
CO4	3	3	3	3	2						2
CO5	3	3	3	3	2						2

Legends :- High: 03, Medium: 02,Low: 01, No Mapping: -

Blooms Level

Remember	Understand ✓	Apply ✓	Analyse ✓	Evaluate	Create

Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25OE12CS21	Emerging Technology and Law	2	--	-	2	2	--	--	2
		Examination Scheme							
			ISE			MSE	ESE	Total	
		Theory	100		--	--	--	100	
		Lab	--		--	--	--	--	

Pre-requisite Course Codes		--
After the successful completion students should be able to:		
Course Outcomes	CO1	To recognize the importance of legal technology domain
	CO2	To demonstrate awareness of the laws related to emerging technologies and legal implications of their work
	CO3	To demonstrate understanding of the impact of emerging/contemporary technologies on the legal ecosystem
	CO4	To demonstrate awareness about company laws, FEMA and few other important acts related to engineering design and consumer protection

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Tech Legal Market**	1	4
	1.1	Legal Marketplace, Impact of Technology on Legal Profession		
	1.2	How technologists can help reshape legal system		
	1.3	Career Development in Legal Tech Domain		
2		**Emerging Technologies and Legal Implications-1**	1	8
	2.1	Cyber Crimes, Cyber Threats and Issues: Information Technology Act 2000		
	2.2	Blockchain and Legal Issues		
	2.3	Legal Implications of Artificial Intelligence		
	2.4	Electronic and Digital Signatures		
	2.5	Implications of Social Media Laws		
3		**Emerging Technologies and Legal Implications-2**	1	6
	3.1	Legal Ecosystem for Autonomous Vehicles and Unmanned Aerial Vehicles (UAV)		
	3.2	Privacy and Data Protection with a Trillion Connected & Cognitive Devices		
	3.3	Legal Ecosystem for 5G		
4		**Company Laws**	2,3	4
	4.1	Companies Act, 1956- Nature and Meaning, Classification of Companies, Incorporation of Companies		
	4.2	Sources of Capital, Board of Directors, Company Meetings		
5		**Regulation and Management of Foreign Exchange**	2,3	2
	5.1	Foreign Exchange Management Act FEMA 1999		
6		**Other Important Laws**	2,3	2

	6.1	Consumer Protection Act, Competition Act 2002, Semiconductor Integrated Circuits Layout-Design Act 2000, Designs Act 2000, Bureau of Indian Standards Act 2016,		
			Total	**26**

Self-Learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.

2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment:

ISE: ISE activities carry 100 marks. These activities will be conducted throughout the semester.

Recommended Books:

1. N. S. Nappinai, "*Technology Laws Decoded*," LexisNexis, 2017
2. Vibha Arora and Kunwar Arora, "*Law for Engineers*" Central Law Publications, 2017
3. Vandana Bhatt and Pinky Vyas, "*Laws for Engineers*", ProCare, 2015.
4. The Information Technology Act, 2000 (21 of 2000) | Bare Act 2026 Edition Paperback – 1 January 2026 by Whitesmann Publishing.
5. 5G and Beyond: Intellectual Property and Competition Policy in the Internet of Things Hardcover – Import, by Jonathan M. Barnett, Cambridge University Press.
6. The LegalTech Book, Editors Akber Datoo, Drago Indjic, Sophia Adams Bhatti, Susanne Chisht by Wiley Publisher.

Online Repository:

1. https://www.sci.gov.in.
2. https://www.youtube.com/watch?v=nOquqbljcbU.
3. https://www.youtube.com/watch?v=RRmNJS35T_g.
4. https://www.youtube.com/watch?v=hLqbEG3LQYw.
5. https://www.youtube.com/watch?v=cMqhvJEDDZ8.
6. https://www.youtube.com/watch?v=gVcgD8TNM70.
7. https://www.youtube.com/watch?v=MrW8hiK72Yw.
8. https://www.youtube.com/watch?v=k5jEkTm5GIU.
9. https://www.youtube.com/watch?v=mahDTt_91qc.
10. https://www.indiacode.nic.in/bitstream/123456789/13116/1/it_act_2000_updated.pdf.
11. https://www.youtube.com/watch?v=Ri69oMUGoo4.

Suggested CO - PO Articulation Matrix

Course Outcomes	Programme Outcomes (POs)										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2				1	3	2	1	2	3	
CO2	2				1	3	2	1	2	3	
CO3	3				1	2	1	3	3	3	
CO4	3				1	2	1	3	3	3	

Legends:- High: 03, Medium: 02,Low: 01, No Mapping: -

Blooms Level

Remember	Understand ✓	Apply ✓	Analyse	Evaluate	Create

Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
25OE12CS22	Principles of Management	L	T	P	SL	L	T	P	Total
		2	--	-	2	2	--	--	2
		Examination Scheme							
			ISE			MSE	ESE	Total	
		Theory	100		--	--	--	100	
		Lab	--		--	--	--	--	

Pre-requisite Course Codes	--	
After the successful completion students should be able to:		
Course Outcomes	CO1	Explain the evolution of management theories and their relevance today
	CO2	Apply planning tools and techniques to real-world business scenarios
	CO3	Explain effective organizational structures based on business requirements
	CO4	Explore different leadership styles and apply appropriate leadership techniques in various situations.
	CO5	Recognize ethical dilemmas in management and apply responsible decision-making frameworks.
	CO6	Apply critical thinking and problem-solving techniques to organizational issues.

Module No.	Topics	Ref.	Hrs
1	**Introduction to Management** Definition and Nature of Management: Understanding management as a process and its significance in organizations. Historical Evolution: Exploration of classical management theories, including contributions from Henri Fayol and Frederick Taylor. Managerial Roles and Skills: Analysis of the roles managers play and the skills required at different managerial levels.	1-5	4
2	**Planning** Strategic and Tactical Planning: Differentiating between long-term strategic planning and short-term tactical planning. Decision-Making Processes: Tools and techniques for effective managerial decision-making. Goal Setting and Management by Objectives (MBO): Establishing clear objectives and aligning them with organizational goals	4-7	5
3	**Organizing** Organizational Structure and Design: Examining various organizational structures and their impact on efficiency. Delegation and Authority: Understanding the distribution of	4-7	4

	authority and responsibility within an organization. Coordination and Communication: Strategies for effective internal communication and coordination among departments.		
4	**Leading** Leadership Theories and Styles: Study of different leadership models and their applicability. Motivation Techniques: Exploring theories of motivation and their implementation in the workplace. Team Dynamics and Group Behaviour: Insights into managing teams and understanding group behaviour.	5-7	5
5	**Control Systems and Processes** Establishing standards and monitoring performance. Financial Controls: Budgeting, financial reporting, and variance analysis. Quality Management: Introduction to quality control techniques and continuous improvement processes.	5-7	4
6	**Contemporary Issues in Management** Ethics and Social Responsibility: The role of ethics in managerial decisions and corporate social responsibility. Globalization and Management: Challenges and strategies in managing international operations. Innovation and Change Management: Managing organizational change and fostering innovation.	5-7	4
		TOTAL	**26**

Self-Learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment:

ISE: ISE activities carry 100 marks. These activities will be conducted throughout the semester.

Recommended Books:

1. Koontz, H., & Weihrich, H. (2010). Essentials of Management: An International Perspective (8th ed.). McGraw-Hill Education.
2. Robbins, S. P., & Coulter, M. (2017). Management (13th ed.). Pearson Education.
3. Daft, R. L. (2018). Management (13th ed.). Cengage Learning.
4. Stoner, J. A. F., Freeman, R. E., & Gilbert, D. R. (1995). Management (6th ed.). Prentice Hall.
5. Drucker, P. F. (2006). The Practice of Management. HarperBusiness.
6. Academy of Management Journal – Provides peer-reviewed research articles on management theory and practices.
7. Journal of Management Studies – Features cutting-edge research in all fields of management.

Suggested CO - PO Articulation Matrix

Course Outcomes	Programme Outcomes (POs)										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1										1	2
CO2										2	1
CO3								2	1	1	
CO4							1	2	2	2	1
CO5						2	2	1		1	1
CO6							1		1	2	2

Legends:- High: 03, Medium: 02,Low: 01, No Mapping: -

Blooms Level

Remember	Understand ✓	Apply ✓	Analyse	Evaluate	Create

Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25VSE12CS03	Web Programming	--	--	4	--		--	2	2
		Examination Scheme							
			ISE			MSE	ESE	Total	
		Theory	--			--	--	--	
		Lab	100			--	--	100	

Pre-requisite Course Codes		--
After the successful completion students should be able to:		
Course Outcomes	CO1	Apply HTML5 and CSS3 effectively to create interactive and dynamic websites.
	CO2	Construct responsive websites using Bootstrap and modern CSS frameworks.
	CO3	Implement client-side scripting using modern JavaScript concepts.
	CO4	Construct full-stack web applications using React.js as front end and Node.js / Express.js as back end.
	CO5	Design and implement database-driven web applications using MongoDB and Mongoose.
	CO6	Implement and deploy web applications using MVC/ component-based architecture with MERN stack.

To be Taught in laboratory			
	Topics wise List of Experiments with relevant topic	**Ref.**	**COs**
1	**Web Programming Fundamentals:** Web application architectures. New elements of HTML5- Image, Links, table, Form, List, Semantic Elements, audio, video, drag-drop, geo location, canvas. Develop static web page using HTML5 tags.	3	1
2	**Cascading Style Sheets:** CSS3 Syntax, Inclusion, Color, Background, Fonts, Tables, Lists, CSS3 selectors, Pseudo classes and Pseudo elements. Apply the Cascading Style Sheet to the html web page	3	1
3	**Bootstrap:** Bootstrap Grid System, Forms, Button, Navbar, Dropdowns and Responsive Tabs, Breadcrumb, Jumbotron. Construct responsive website using Bootstrap.	3	2
4	**JavaScript:** Variables, Operators, Conditions, Loops, Functions, Events, , Error handling, Validations, Built-in Objects (Arrays, String , Date), DOM Manipulation, ECMAScript - ES5,ES6,ES7,ES8- Classes, Arrow Functions, Promises, Iterators. Apply JavaScript to make the webpage interactive.	3	3
5	**React:**	3	4

	JSX, Components, Props, State, Forms, Events, Keys, Refs, React Router, Hooks (useState, useEffect), Component Lifecycle, Flux Architecture concepts. Design a single-page application (SPA) using React.js. Build Process for frontend (React Build), Environment variables (.env handling)		
6	**Node.js and Express.js:** Asynchronous Programming, Callback Concept, Event Loop, Event Emitter, Node.js Modules, Express Router, Middleware, RESTful APIs, Authentication, Integration with React Frontend. Create a server-side web application using Node.js and Express.js.	3	4
7	**MongoDB and Database Integration:** Introduction to MongoDB, NoSQL concepts, Collections and Documents, CRUD Operations, Mongoose Schemas and Models, Connecting MongoDB with Express.js. Implement database connectivity and CRUD operations using MongoDB. Database deployment on MongoDB Atlas.	3	5
8	**MVC Framework:** Model–View–Controller / Component-based Architecture, Frontend–Backend Integration, User Authentication & Authorization, API Consumption , Error Handling.	3	6
9	**Web Application Deployment:** Deploy a full-stack MERN application: Frontend- Vercel / Netlify Backend- Render / Railway Database- MongoDB Atlas CI/ CD basics- (GitHub Actions) Test live API integration with debugging production issues and share deployed URL. Implementation and deployment of MVC-based mini project.	9,10	6

Course Assessment: - (Lab)

ISE: Laboratory ISE is divided into two components: 75 marks for submission of experiments and 25 marks for oral/practical evaluation.

Recommended Books:

1. Christopher Schmitt, Kyle Simpson, "HTML5 Cookbook", O'Reilly Media
2. Eric Meyer, "CSS Pocket Reference, 5th Edition", O'Reilly Media, Inc., 2018
3. Venkat Subramaniam, "Rediscovering JavaScript, Master ES6, ES7, and ES8", 2018
4. Alex Banks and Eve Porcello, "Learning React Functional Web Development with React and Redux", O'Reilly
5. Andrew Mead, "Learning Node.js Development", Packt Publishing
6. Juha Hinkula, "Full Stack Development with Spring Boot and React -Third Edition", Packt Publishing
7. "Beginning JSP 2.0, Build Web Applications using JSP, Java, Struts", Wrox Publications
8. Ed Roman, Rima Patel Sriganesh, Gerald Brose, "Mastering Enterprise JavaBeans", Wiley Publications

9. Vasan Subramanian, "Pro Mern Stack", Apress, 2nd edition
10. Daniel Bugl, "Modern Full-Stack React Projects: Build, maintain, and deploy modern web apps using MongoDB, Express, React, and Node.js", Packt Publications, 1st edition

Suggested CO - PO Articulation Matrix

Course Outcomes	Programme Outcomes (POs)										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2		2		3						
CO2	2		3		3						
CO3	2		2		3						
CO4	2		3		3						
CO5	2	3	3		3						
CO6	2	2	3		3						

Legends: - High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms level

Remember	Understand	Apply ✓	Analyse	Evaluate	Create

Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25EEM12CS02	Technology Entrepreneurship	2	--	-	2	2	--	--	2
		Examination Scheme							
			ISE			MSE	ESE	Total	
		Theory	100			--	--	100	
		Lab	--			--	--	--	

Pre-requisite Course Codes		--
After the successful completion students should be able to:		
Course Outcomes	CO1	Analyze real-world problems using effectuation principles to identify viable entrepreneurial opportunities.
	CO2	Develop a Value Proposition Canvas and Lean Business Model for a technology-based startup idea.
	CO3	Prepare a structured business plan incorporating finance, marketing, operations, and MVP strategy.
	CO4	Apply company formation procedures including registration, capital structure, and branding for a virtual startup.

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Opportunity Discovery**	1	6
	1.1	Self-discovery		
	1.2	Effectuation Principle		
	1.3	Identification of problem worth solving		
	1.4	Looking for solutions		
	1.5	Present the problem		
2		**Value Proposition Canvas and Business Model**	2,3	7
	2.1	Craft your value proposition		
	2.2	Presentation of Value Proposition Canvas		
	2.3	Business Model and Lean Approach(Finance, Marketing, Operations)		
	2.4	Presentation of Lean Canvas		
3		**Business Plan**	4	6
	3.1	Creation of Business Plan, Introduction to Minimum Viable product (MVP)		
4		**Company Formation**	5	7
	4.1	Promoters, Capital, Shareholders		
	4.2	Directors, DIN		
	4.3	Company Name, Registrations		
	4.4	Branding		
			Total	**26**

Self-Learning:
1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment:

ISE: ISE activities carry 100 marks. These activities will be conducted throughout the semester.

Recommended Books:

1. Sarasvathym "Elements of Entrepreneurial Expertise (New Horizons in Entrepreneurship Series)" Edward Elgar Publishing.
2. Alexander Osterwalder "Business Model Generation :A Handbook for Visionaries, Game Changers, and Challengers"
3. Alex Osterwalder, Yves Pigneur, Greg Bernarda, Alan Smith, Trish Papadakos "Value Proposition Design: How to create Products and Services Customers Want"
4. Garrett Sutton "Writing Winning Business Plans"
5. M.C. Bhandari "Company Law Procedures" LexiNexis, 2018

Suggested CO - PO Articulation Matrix

Course Outcomes	Programme Outcomes (POs)										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1		3				2			2	2	
CO2		2	3						2	3	2
CO3		2	3						2	3	3
CO4			2			2		2		2	3

Legends:- High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms Level

Remember	Understand ✓	Apply ✓	Analyse ✓	Evaluate	Create

Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25VEC12CS02	Technology Innovation for Sustainable Development	1	--	2	1	1	--	1	2
		Examination Scheme							
			ISE			MSE	ESE	Total	
		Theory	--			--	--	--	
		Lab	100			--	--	100	

Pre-requisite Course Codes		--
After the successful completion students should be able to:		
Course Outcomes	CO1	Demonstrate a broad and coherent knowledge of United Nations Sustainable Development Goals (SDGs)
	CO2	Build the vocabulary and develop a nuanced understanding of the SDG themes: people, planet, prosperity, peace and partnership
	CO3	Identify technological solutions to address challenges of SDGs
	CO4	Build the vision to explain how to create a technological solution for sustainability

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**What are SDGs**	1,2,3	3
	1.1	Concept of Sustainability. The Role of UN and the Need for SDGs. Why SDGs are important.		
	1.2	Introduction to 17 SDGs		
2		**People Theme**	4,5	4
	2.1	Sustainable development goals 1-5		
	2.2	Technological Solutions to advance people theme		
3		**Planet Theme**	4,5	6
	3.1	Sustainable development goals 6, 12-15		
	3.2	Technological Solutions to advance planet theme		
4		**Prosperity Theme**	4,5	7
	4.1	Sustainable development goals 7-11		
	4.2	Technological Solutions to advance prosperity theme		
5		**Peace Theme**	4,5	3
	5.1	Sustainable development goal 16		
	5.2	Technological Solutions to advance peace theme		
6		**Partnership Theme**	4,5	3
	4.1	Sustainable development goals 17		
	4.2	Technological Solutions to advance partnership theme		
			Total	**26**

Self-Learning:
1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment:

ISE: ISE activities carry 100 marks. These activities will be conducted throughout the semester.

References:

1. United Nations. Transforming Our World: The 2030 Agenda for Sustainable Development. United Nations, 2015.
2. United Nations Sustainable Development Goals (SDGs) – Official Website: https://sdgs.un.org/goals
3. Jeffrey D. Sachs. The Age of Sustainable Development. Columbia University Press, 2015.
4. World Bank. Sustainable Development Overview. https://www.worldbank.org/en/topic/sustainabledevelopment
5. UNDP (United Nations Development Programme). Sustainable Development Goals Resources. https://www.undp.org/sustainable-development-goals
6. Kumar, A., & Reddy, B. Technology and Sustainable Development: Applications and Case Studies. Springer Publications.
7. MIT OpenCourseWare – Sustainability and Technology Resources. https://ocw.mit.edu

Suggested CO - PO Articulation Matrix

Course Outcomes	Programme Outcomes (POs)										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	1					2	3	1			
CO2	1					2	3	1			
CO3	2	2	3		2	2	3	1	1	1	1
CO4	2	2	3		2	2	3	1	1	1	2

Legends: - High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms Level

Remember	Understand	Apply ✓	Analyse ✓	Evaluate	Create