CURRICULUM FRAMEWORK AND SYLLABUS

FOR

FIVE YEAR INTEGRATED M.Sc. (DATA SCIENCE) DEGREE PROGRAMME

IN CHOICE BASED CREDIT SYSTEM

FOR THE STUDENTS ADMITTED FROM THE

ACADEMIC YEAR 2026-2027 ONWARDS

THIAGARAJAR COLLEGE OF ENGINEERING
(A Government Aided Autonomous Institution affiliated to Anna University)

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THIAGARAJAR COLLEGE OF ENGINEERING, MADURAI 625 015

DEPARTMENT OF APPLIED MATHEMATICS AND COMPUTATIONAL SCIENCE

VISION

"Academic and research excellence in Computational Science"

MISSION

As a Department, we are committed to

- Achieve academic excellence in Computational Science through innovative teachingand learning processes.
- Enable the students to be technically competent to solve the problems faced by theindustry.
- Create a platform for pursuing inter-disciplinary research among the faculty and thestudents to create state of art research facilities.
- Promote quality and professional ethics among the students.
- Help the students to learn entrepreneurial skills.

Programme Educational Objectives (PEO)

Post graduates of M.Sc.(Data Science) program will be

PEO1: Utilizing strong quantitative aptitude and domain knowledge to apply quantitative modeling and data analysis techniques to provide solutions to the real-world business problems.

PEO2: Applying research and entrepreneurial skills augmented with a rich set of communication, teamwork, and leadership skills to excel in their profession.

PEO3: Showing continuous improvement in their professional career through life-long learning, appreciating human values and ethics.

Programme Outcomes (PO) for M.Sc. (Data Science)

On completion of the programme, the students are expected to

1. **Engineering knowledge:** Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop solutions to complex engineering problems as specified in WK1--WK4 to develop solutions to complex engineering

2. **Problem analysis**: — Identify, formulate, review research literature and analyse complex engineering problems reaching substantiated conclusions with holistic consideration for sustainable development.

3. **Design/development of solutions**: Design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for sustainability

4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling recognising their limitations to solve complex engineering problems

6. **The engineer and World** Analyse and evaluate societal and environmental aspects while solving complex engineering problems for their impact on sustainability with

reference to economy, health, safety, legal frameworks, culture, and environment.

7. **Ethics:** Apply ethical principles and commit to professional ethics, human values, diversity, and inclusion; adhere to national and international laws.

8. **Individual and collaborative team work:** Function effectively as an individual and as a member or leader in diverse, multi-disciplinary teams in face-to-face, remote, and distributed settings.

9. **Communication:** Communicate effectively and inclusively within the engineering community and society at large, such as comprehending and writing effective reports, design documentation, and making effective presentations considering cultural, language, and learning differences.

10. **Project management and finance:** Apply knowledge and understanding of engineering management principles and economic decision-making to one's own work, as a member and leader in a team, to manage projects in multidisciplinary environments.

11. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSO) for M.Sc. Data Science

PSO1: To become a skilled Data Scientist in industry, academia, or government by independently carrying out research based statistical experiments to solve analytical problems following the ethics for data science

PSO2: To exhibit professional and interpersonal skills in data collection and its analysis using mathematical modelling and statistical techniques, querying and reporting for business and societal requirements using state-of-the-art tools.

PEO-PO & PSO Mapping:

PEO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1														
2														
3														

Identified Performance Indicators:

Graduate Attributes (GA) – PO — Competency & Performance Indicators

GA-PO	Competency Indicator (CI)	PI Code	Performance Indicator (PI)
PO1-GA1: Engineering Knowledge — Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop solutions to complex engineering problems.			
GA1	1.1 Mathematical modelling	**1.1.1**	Apply knowledge of discrete mathematics, linear algebra, probability, statistics, optimization techniques, and numerical methods to solve data science and computational problems. [TPS 3 – Apply]
	1.2 Natural sciences	**1.2.1**	Apply principles of natural sciences and related domains to analyse real-world data science applications and computational systems. [TPS 3 – Apply]
	1.3 Engineering fundamentals	**1.3.1**	Apply fundamental data science and computing concepts to formulate and solve complex data-driven problems. [TPS 3 – Apply]
	1.4 Specialized CSE/IT knowledge	**1.4.1**	Apply theories and principles of data science, machine learning, databases, algorithms, and intelligent systems to solve complex analytical and computational problems. [TPS 3 – Apply]
PO2-GA2: Problem Analysis — Identify, formulate, review research literature and analyse complex engineering problems reaching substantiated conclusions with holistic consideration for sustainable development.			
GA2	2.1 Identify and formulate complex problems	**2.1.1**	Examine data science problem statements to identify objectives, scope, datasets, computational requirements, and analytical parameters. [TPS 4 – Examine]
	2.1 Identify and formulate complex problems	**2.1.2**	Infer the mathematical, statistical, algorithmic, and domain knowledge applicable to a given data science problem. [TPS 4 – Infer]
	2.2 Formulate a sustainable solution plan	**2.2.1**	Decompose a data-driven system into interconnected modules by investigating relevant literature and identifying assumptions and constraints. [TPS 4 – Decompose]

GA-PO	Competency Indicator (CI)	PI Code	Performance Indicator (PI)
	2.2 Formulate a sustainable solution plan	**2.2.2**	Decide appropriate analytical or computational approaches for solving complex data science problems considering performance and sustainability aspects. [TPS 5 – Decide]
	2.3 Formulate and interpret a model	**2.3.1**	Formulate models and workflows for data-driven systems by applying mathematical, statistical, and computational principles. [TPS 6 – Formulate]
	2.4 Execute solution and analyse results	**2.4.1 / 2.4.2**	Implement solutions using statistical methods, ML techniques, and computational tools, and validate outcomes; analyse results, identify limitations, and derive conclusions consistent with problem objectives. [TPS 3/4]
PO3-GA3: Design/Development of Solutions — Design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for sustainability.			
GA3	3.1 Define a complex/open-ended problem	**3.1.1**	Formulate clear problem statements with defined objectives, constraints, and requirements for data science applications. [TPS 6 – Formulate]
	3.1 Define a complex/open-ended problem	**3.1.2**	Examine stakeholder needs to identify functional and non-functional requirements of data-driven systems. [TPS 4 – Examine]
	3.1 Define a complex/open-ended problem	**3.1.3**	Investigate recent developments and technologies to identify suitable approaches for data science and intelligent system applications. [TPS 4 – Investigate]
	3.1 Define a complex/open-ended problem	**3.1.4**	Compose requirement and design documents for data science applications including system specifications and analytical workflows. [TPS 6 – Compose]
	3.2 Generate diverse alternative design solutions	**3.2.1**	Generate alternative design solutions for data collection, processing, analytics, and intelligent decision-making systems. [TPS 6 – Generate]
	3.2 Generate diverse alternative design solutions	**3.2.2**	Compare alternative analytical and computational solutions based on performance, scalability, sustainability, and usability criteria. [TPS 4 – Compare]
	3.3 Select optimal design / 3.4 Advance to end state	**3.3.1 / 3.4.1**	Evaluate alternative solution approaches and select an appropriate design; develop and integrate data science models, software modules, and intelligent systems within defined requirements and constraints. [TPS 5/6]
PO4-GA4: Conduct Investigations of Complex Problems — Conduct investigations using research-based knowledge, design of experiments, modelling, analysis, and interpretation of data to provide valid conclusions.			
GA4	4.1 Conduct investigations using research-based knowledge	**4.1.1**	Examine emerging problems in data science and analytics using research-based knowledge and computational thinking. [TPS 4 – Examine]
	4.1 Conduct investigations using research-based knowledge	**4.1.2**	Examine and justify suitable datasets, tools, platforms, and methodologies for conducting data science investigations. [TPS 4 – Examine]
	4.2 Design experiments and modelling	**4.2.1**	Design experiments, analytical procedures, and data collection methods for solving open-ended data science problems. [TPS 6 – Design]
	4.3 Analyse and interpret data	**4.3.1 /**	Analyse data using statistical, computational, and visualization

GA-PO	Competency Indicator (CI)	PI Code	Performance Indicator (PI)
		4.3.2	techniques to identify trends, patterns, and limitations; conclude on validity of findings and present meaningful insights. [TPS 4/5]
PO5-GA5: Engineering Tool Usage — Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, recognising their limitations.			
GA5	5.1 Identify/create modern engineering tools	**5.1.1**	Apply modern data science and computing tools, platforms, and technologies to perform analytical and computational tasks. [TPS 3 – Apply]
	5.2 Select and apply discipline-specific tools	**5.2.1**	Operate discipline-specific tools and technologies for data processing, visualization, modelling, and intelligent system development. [TPS 3 – Operate]
	5.3 Evaluate suitability and limitations of tools	**5.3.1**	Validate the suitability and limitations of analytical tools, models, and computational techniques used in solving data science problems. [TPS 5 – Validate]
PO6-GA6: The Engineer and The World — Analyse and evaluate societal and environmental aspects while solving complex engineering problems for their impact on sustainability.			
GA6	6.1 Engineering roles in broader context	**6.1.1**	Analyse the roles and responsibilities of data science professionals in protecting public interest at global, regional, and local levels. [TPS 4 – Analyse]
	6.2 Professional regulations and standards	**6.2.1**	Examine relevant regulations, standards, and privacy policies related to data science and intelligent systems and explain their contribution to professional accountability. [TPS 4 – Examine]
	6.3 Impact on social/environmental/economic contexts	**6.3.1**	Evaluate the life cycle risks and social, economic, environmental, and technological impact of data-driven systems and AI-based solutions. [TPS 5 – Evaluate]
	6.4 Principles of sustainable design	**6.4.1**	Apply principles of sustainable computing, responsible AI, and ethical data usage in data science activities. [TPS 3 – Apply]
PO7-GA7: Ethics — Apply ethical principles and commit to professional ethics, human values, diversity, and inclusion; adhere to national and international laws.			
GA7	7.1 Recognise professional ethics and human values	**7.1.1**	Examine situations of unethical professional conduct in computing contexts against principles of human values, diversity, inclusion, and professional norms, and propose ethically justified alternatives. [TPS 4 – Examine]
	7.2 Apply professional codes of ethics	**7.2.1**	Apply professional ethics, standards, and legal guidelines to resolve ethical issues in data science and computing practices. [TPS 3 – Apply]
PO8-GA8: Individual and Collaborative Team Work — Function effectively as an individual and as a member or leader in diverse, multi-disciplinary teams.			
GA8	8.1 Participate in and organise collaborative teams	**8.1.1**	Explain the value of team diversity and norms of effective collaborative practice, and implement team roles, charters, and agendas to accomplish a goal. [TPS 2 – Explain]
	8.2 Effective individual contribution and collaboration	**8.2.1**	Demonstrate effective communication, problem-solving, conflict management, and leadership skills as both an individual contributor and team member in face-to-face, remote, and distributed settings. [TPS 3 – Demonstrate]

GA-PO	Competency Indicator (CI)	PI Code	Performance Indicator (PI)
	8.2 Effective individual contribution and collaboration	**8.2.2**	Apply respectful and inclusive interpersonal practices by actively listening, appreciating diversity of thought, and maintaining composure in challenging team situations. [TPS 3 – Apply]
	8.3 Work productively in diverse/multidisciplinary teams	**8.3.1**	Construct integrated project outcomes by coordinating and synthesising contributions from all members of diverse or multidisciplinary software engineering and data analytics teams. [TPS 6 – Construct]
PO9-GA9: Communication — Communicate effectively and inclusively within the engineering community and society at large.			
GA9	9.1 Comprehend technical literature and document project work	**9.1.1**	Interpret technical and non-technical information from literature, datasets, and project documents related to data science applications. [TPS 2 – Interpret]
	9.1 Comprehend technical literature and document project work	**9.1.2**	Compose clear technical reports, analytical summaries, and project documentation with logical organization and clarity. [TPS 6 – Compose]
	9.2 Listening, speaking & presentation / 9.3 Integrate communication modes	**9.2.1 / 9.3.1**	Demonstrate effective oral presentation and active listening skills; compose visualizations, reports, dashboards, and multimedia materials that communicate analytical findings, adapting to cultural, linguistic, and learning contexts. [TPS 3/6]
PO10-GA10: Project Management and Finance — Apply knowledge and understanding of engineering management principles and economic decision-making.			
GA10	10.1 Evaluate economic and financial performance	**10.1.1**	Analyse the economic and financial aspects of data science projects by examining resource utilization, costs, and benefits. [TPS 4 – Analyse]
	10.2 Compare costs/benefits of alternate proposals	**10.2.1**	Decide on the most appropriate data analytics proposal based on a comprehensive analysis of costs, benefits, and financial implications of alternatives. [TPS 5 – Decide]
	10.3 Plan/manage engineering activity within constraints	**10.3.1**	Implement project management practices to plan, monitor, and complete data science activities within time and resource constraints. [TPS 3 – Implement]
PO11-GA11: Life-long Learning — Recognise the need for, and have the preparation and ability to engage in independent and life-long learning.			
GA11	11.1 Identify gaps in knowledge	**11.1.1**	Explain the need for continuous learning and identify credible resources to enhance knowledge and skills in data science and emerging technologies. [TPS 2 – Explain]
	11.2 Adapt to emerging technologies	**11.2.1**	Analyse current and emerging technologies in data science, artificial intelligence, and computing to support continuous professional growth. [TPS 4 – Analyse]
	11.3 Evaluate emerging issues	**11.3.1**	Assess emerging issues and technologies in data science and intelligent systems by critically evaluating technical developments. [TPS 5 – Assess]

Five Year Integrated M.Sc (Data Science) Degree Programme Curriculum

2026-2027 Onwards
CHOICE BASED CREDIT SYSTEM

Credit Distribution:

S. No.	Category of courses	Credits	Percentage of Credits To TotalCredits
1	Foundation Courses	49	22.2
2	Professional Core Courses- Theory	87	39.4
3	Professional Core Courses- Practical	29	13.1
4	Professional Elective Courses	15	6.8
5	Employability Enhancement Courses	41	18.5
6	Audit Courses	0	0
	Total Credits	**221**	**100%**

Foundation courses (FC): 49 credits

S. No.	Course Code	Name Of the Course	Category	No. Of Hours / Week			Credits
				L	T	P	
1.	26DSKA0	CALCULUS	FC	3	1	0	4
2.	26DSKB0	DISCRETE STRUCTURES	FC	3	1	0	4
3.	26DSKC0	DIGITAL ELECTRONICS AND COMPUTER ORGANIZATION	FC	4	0	0	4
4.	26DSKD0	PROBLEM SOLVING USING C PROGRAMMING	FC	4	0	0	4
5.	26DSKE0	FOUNDATIONS OF DATA SCIENCE	FC	3	0	0	3
6.	26DSEA0	C PROGRAMMING LAB	FC	0	0	4	2
7.	26DSKF0	THEORY OF PROBABILITY	FC	3	1	0	4
8.	26DSKG0	GRAPH THEORY	FC	3	1	0	4
9.	26DSKH0	PARTIAL DIFFERENTIAL EQUATIONS AND TRANSFORMS	FC	3	1	0	4
10.	26DSKJ0	LINEAR ALGEBRA FOR DATA SCIENCE	FC	3	1	0	4
11.	26DSKK0	NUMERICAL METHODS	FC	3	1	0	4
12.	26DSKL0	OPTIMIZATION TECHNIQUES	FC	3	1	0	4
13.	26DSKM0	STOCHASTIC MODEL	FC	3	1	0	4

Professional Core Courses- Theory (PCC): 87 credits

S. No.	Course code	Name of the Course	Category	No. of Hours / Week			credits
				L	T	P	
1.	26DSCA0	DATA STRUCTURES	PCC	4	0	0	4
2.	26DSCB0	OBJECT ORIENTED PROGRAMMING	PCC	4	0	0	4
3.	26DSCC0	ORGANIZATIONAL THEORY ANDBEHAVIOUR	PCC	3	0	0	3
4.	26DSCD0	APPLIED STATISTICS	PCC	3	1	0	4
5.	26DSCE0	ADVANCED DATA STRUCTURES	PCC	4	0	0	4
6.	26DSCF0	DATABASE MANAGEMENT SYSTEMS	PCC	4	0	0	4
7.	26DSCG0	OPERATING SYSTEMS	PCC	3	0	0	3
8.	26DSCH0	PREDICTIVE ANALYTICS	PCC	3	1	0	4
9.	26DSCJ0	DATA MINING	PCC	3	1	0	4
10.	26DSCK0	DESIGN AND ANALYSIS OF ALGORITHMS	PCC	4	0	0	4
11.	26DSCL0	SOFTWARE ENGINEERING	PCC	3	0	0	3
12.	26DSCM0	MACHINE LEARNING	PCC	3	1	0	4
13.	26DSCN0	FULL STACK WEB TECHNOLOGIES	PCC	4	0	0	4
14.	26DSCP0	COMPUTER NETWORKS	PCC	3	0	0	3
15.	26DSCQ0	DEEP LEARNING	PCC	4	0	0	4
16.	26DSCR0	BUSINESS ANALYTICS AND DATA VISUALIZATION	PCC	4	0	0	4
17.	26DSCS0	ETHICS FOR DATA SCIENCE	PCC	3	0	0	3
18.	26DSCT0	REINFORCEMENT LEARNING	PCC	4	0	0	4
19.	26DSCU0	NATURAL LANGUAGE PROCESSING	PCC	4	0	0	4
20.	26DSCV0	BIG DATA SYSTEMS	PCC	4	0	0	4
21.	26DSCW0	WEB ANALYTICS	PCC	4	0	0	4
22.	26DSCX0	GENERATIVE AI	PCC	4	0	0	4
23.	26DSCY0	COMPUTER VISION	PCC	3	1	0	4

Professional Core Courses- Laboratory (PCC): 29 credits

S. No.	Course code	Name of the Course	Category	No. of Hours / Week			credits
				L	T	P	
1.	26DSEB0	DATA STRUCTURES LAB	PCC	0	0	6	3
2.	26DSEC0	OBJECT ORIENTED PROGRAMMING USING C++ LAB	PCC	0	0	4	2
3.	26DSED0	PYTHON PROGRAMMING AND APPLIED STATISTICS LAB	PCC	0	0	6	3
4.	26DSEE0	DATABASE MANAGEMENT SYSTEMS LAB	PCC	0	0	4	2
5.	26DSEF0	PREDICTIVE ANALYTICS LAB	PCC	0	0	4	2
6.	26DSEG0	ALGORITHM IMPLEMENTATION USING JAVA LAB	PCC	0	0	6	3
7.	26DSEH0	FULL STACK WEB DEVELOPMENT LAB	PCC	0	0	4	2
8.	26DSEJ0	DEEP LEARNING LAB	PCC	0	0	4	2
9.	26DSEK0	BUSINESS ANALYTICS AND VISUALIZATION LAB	PCC	0	0	4	2
10.	26DSEL0	NATURAL LANGUAGE PROCESSING LAB	PCC	0	0	4	2
11.	26DSEM0	BIG DATABASE SYSTEMS LAB	PCC	0	0	4	2
12.	26DSEN0	WEB ANALYTICS LAB	PCC	0	0	4	2
13.	26DSEP0	MATHEMATICAL COMPUTING USING R PROGRAMMING LAB	PCC	0	0	4	2

Professional Elective Courses (PEC):15 credits from 5 elective courses

S. No.	Course code	Name of the Course	Category	No. of Hours / Week			credits
				L	T	P	
1.	26DSPA0	ACCOUNTING AND FINANCIAL MANAGEMENT	PEC	3	0	0	3
2.	26DSPB0	AGENTIC AI	PEC	3	0	0	3
3.	26DSPC0	CLOUD COMPUTING	PEC	3	0	0	3
4.	26DSPD0	COMPUTATIONAL FINANCE	PEC	3	0	0	3
5.	26DSPE0	COMPUTATIONAL SYSTEM BIOLOGY	PEC	3	0	0	3
6.	26DSPF0	COMPUTATIONAL GEOMETRY	PEC	3	0	0	3
7.	26DSPG0	CYBER SECURITY	PEC	3	0	0	3
8.	26DSPH0	EMBEDDED SYSTEM	PEC	3	0	0	3
9.	26DSPJ0	ENTERPRISE INFORMATION SYSTEM	PEC	3	0	0	3
10.	26DSPK0	EXPLAINABLE ARTIFICIAL INTELLIGENCE	PEC	3	0	0	3
11.	26DSPL0	GRAPH ALGORITHMS	PEC	3	0	0	3
12.	26DSPM0	HEALTHCARE INFORMATICS	PEC	3	0	0	3
13.	26DSPN0	INFORMATION RETRIEVAL	PEC	3	0	0	3
14.	26DSPP0	INTERNET OF THINGS AND DATA ANALYTICS	PEC	3	0	0	3
15.	26DSPQ0	LARGE LANGUAGE MODELS	PEC	3	0	0	3
16.	26DSPR0	MARKETING ANALYTICS	PEC	3	0	0	3
17.	26DSPS0	MOBILE APPLICATION DEVELOPMENT	PEC	3	0	0	3
18.	26DSPT0	NETWORK SCIENCE	PEC	3	0	0	3
19.	26DSPU0	PRINCIPLES OF MANAGEMENT	PEC	3	0	0	3
20.	26DSPV0	QUANTUM COMPUTING	PEC	3	0	0	3
21.	26DSPW0	RANDOMIZED ALGORITHMS	PEC	3	0	0	3
22.	26DSPX0	SOCIAL MEDIA ANALYTICS	PEC	3	0	0	3
23.	26DSPY0	SPEECH PROCESSING & RECOGNITION	PEC	3	0	0	3
24.	26DSPZ0	VIDEO ANALYTICS	PEC	3	0	0	3

Employability Enhancement Courses (EEC): 41 credits

S. No.	Course code	Name of the Course	Category	No. of Hours / Week			credits
				L	T	P	
1.	26DSLA0	PROFESSIONAL ENGLISH	EEC	0	2	2	3
2.	26DSLD0	MINI PROJECT	EEC	0	0	4	2
3.	26DSLE0	PROJECT WORK I	EEC	0	0	32	16
4.	26DSLF0	PROJECT WORK II	EEC	0	0	32	16
5.	26CCLA0	BUILDING COMMUNICATION SKILLS	EEC	0	0	2	1
6.	26CCLB0	NUMERACY SKILLS AND QUANTITATIVE PROBLEM SOLVING	EEC	0	0	2	1
7.	26CCLC0	APTITUDE SKILLS	EEC	0	0	4	2

Audit Courses (AC):

S. No.	Course code	Name of the Course	Category	No. of Hours / Week			credits
				L	T	P	
1.	26CCAA0	VISION AND SPEED MATHS	AC	0	0	2	0
2.	26CCAB0	FOUNDATIONS OF PROBLEM SOLVING	AC	0	0	2	0

Thiagarajar College of Engineering, Madurai
Five year Integrated M.Sc (Data Science) Degree Programme [2026-2027] onwards
Choice Based Credit System
Courses of Study

FIRST SEMESTER

Course code	Course Title	Category	No. of Hours / Week			credits
			L	T	P	
THEORY						
26DSKA0	CALCULUS	FC	3	1	0	4
26DSKB0	DISCRETE STRUCTURES	FC	3	1	0	4
26DSKC0	DIGITAL ELECTRONICS AND COMPUTER ORGANIZATION	FC	4	0	0	4
26DSKD0	PROBLEM SOLVING USING C PROGRAMMING	FC	4	0	0	4
26DSKE0	FOUNDATIONS OF DATA SCIENCE	FC	3	0	0	3
PRACTICAL						
26DSEA0	C PROGRAMMING LAB	FC	0	0	4	2
26DSLA0	PROFESSIONAL ENGLISH	EEC	0	2	2	3
		TOTAL	17	4	6	24

SECOND SEMESTER

Course code	Course Title	Category	No. of Hours / Week			credits
			L	T	P	
THEORY						
26DSKF0	THEORY OF PROBABILITY	FC	3	1	0	4
26DSKG0	GRAPH THEORY	FC	3	1	0	4
26DSCA0	DATA STRUCTURES	PCC	4	0	0	4
26DSCB0	OBJECT ORIENTED PROGRAMMING	PCC	4	0	0	4
26DSCC0	ORGANIZATIONAL THEORY AND BEHAVIOUR	PCC	3	0	0	3
PRACTICAL						
26DSEB0	DATA STRUCTURES LAB	PCC	0	0	6	3
26DSEC0	OBJECT ORIENTED PROGRAMMING USING C++ LAB	PCC	0	0	4	2
		TOTAL	17	2	10	24

THIRD SEMESTER

Course code	Course Title	Category	No. of Hours / Week			credits
			L	T	P	
THEORY						
26DSKH0	PARTIAL DIFFERENTIAL EQUATIONS AND TRANSFORMS	FC	3	1	0	4
26DSCD0	APPLIED STATISTICS	PCC	3	1	0	4
26DSCE0	ADVANCED DATA STRUCTURES	PCC	4	0	0	4
26DSCF0	DATABASE MANAGEMENT SYSTEMS	PCC	4	0	0	4
26DSCG0	OPERATING SYSTEMS	PCC	3	0	0	3
PRACTICAL						
26DSED0	PYTHON PROGRAMMING AND APPLIED STATISTICS LAB	PCC	0	0	6	3
26DSEE0	DATABASE MANAGEMENT SYSTEMS LABORATORY	PCC	0	0	4	2
		TOTAL	17	2	10	24

FOURTH SEMESTER

Course code	Course Title	Category	No. of Hours / Week			credits
			L	T	P	
THEORY						
26DSKJ0	LINEAR ALGEBRA FOR DATA SCIENCE	FC	3	1	0	4
26DSCH0	PREDICTIVE ANALYTICS	PCC	3	1	0	4
26DSCJ0	DATA MINING	PCC	3	1	0	4
26DSCK0	DESIGN AND ANALYSIS OF ALGORITHMS	PCC	4	0	0	4
26DSCL0	SOFTWARE ENGINEERING	PCC	3	0	0	3
PRACTICAL						
26DSEF0	PREDICTIVE ANALYTICS LAB	PCC	0	0	4	2
26DSEG0	ALGORITHM IMPLEMENTATION USING JAVA LAB	PCC	0	0	6	3
		TOTAL	16	3	10	24

FIFTH SEMESTER

Course code	Course Title	Category	No. of Hours / Week			credits
			L	T	P	
THEORY						
26DSKK0	NUMERICAL METHODS	FC	3	1	0	4
26DSKL0	OPTIMIZATION TECHNIQUES	FC	3	1	0	4
26DSCM0	MACHINE LEARNING	PCC	3	1	0	4
26DSCN0	FULL STACK WEB TECHNOLOGIES	PCC	4	0	0	4
26DSCP0	COMPUTER NETWORKS	PCC	3	0	0	3
PRACTICAL						
26DSEH0	FULL STACK WEB DEVELOPMENT LAB	PCC	0	0	4	2
26DSLD0	MINI PROJECT	EEC	0	0	4	2
		TOTAL	16	3	8	23

SIXTH SEMESTER

Course code	Course Title	Category	No. of Hours / Week			credits
			L	T	P	
THEORY						
26DSKM0	STOCHASTIC MODEL	FC	3	1	0	4
26DSCQ0	DEEP LEARNING	PCC	4	0	0	4
26DSCR0	BUSINESS ANALYTICS AND DATA VISUALIZATION	PCC	4	0	0	4
26DSCS0	ETHICS FOR DATA SCIENCE	PCC	3	0	0	3
26DSPX0	PROFESSIONAL ELECTIVE-I	PEC	3	0	0	3
PRACTICAL						
26DSEJ0	DEEP LEARNING LAB	PCC	0	0	4	2
26DSEK0	BUSINESS ANALYTICS AND VISUALIZATION LAB	PCC	0	0	4	2
		TOTAL	17	1	8	22

SEVENTH SEMESTER

Course code	Course Title	Category	No. of Hours / Week			credits
			L	T	P	
26DSLE0	PROJECT WORK I	EEC	0	0	32	16

EIGTH SEMESTER

Course code	Course Title	Category	No. of Hours / Week			credits
			L	T	P	
THEORY						
26DSCT0	REINFORCEMENT LEARNING	PCC	4	0	0	4
26DSCU0	NATURAL LANGUAGE PROCESSING	PCC	3	1	0	4
26DSCV0	BIG DATA SYSTEMS	PCC	4	0	0	4
26DSPX0	PROFESSIONAL ELECTIVE-II	PEC	3	0	0	3
26DSPX0	PROFESSIONAL ELECTIVE-III	PEC	3	0	0	3
PRACTICAL						
26DSEL0	NATURAL LANGUAGE PROCESSING LAB	PCC	0	0	4	2
26DSEM0	BIG DATABASE SYSTEMS LAB	PCC	0	0	4	2
		TOTAL	17	1	8	22

NINTH SEMESTER

Course code	Course Title	Category	No. of Hours / Week			credits
			L	T	P	
THEORY						
26DSCW0	WEB ANALYTICS	PCC	4	0	0	4
26DSCX0	GENERATIVE AI	PCC	4	0	0	4
26DSCY0	COMPUTER VISION	PCC	3	1	0	4
26DSPX0	PROFESSIONAL ELECTIVE-IV	PEC	3	0	0	3
26DSPX0	PROFESSIONAL ELECTIVE-V	PEC	3	0	0	3
PRACTICAL						
26DSEN0	WEB ANALYTICS LAB	PCC	0	0	4	2
26DSEP0	MATHEMATICAL COMPUTING USING R PROGRAMMING LAB	PCC	0	0	4	2
		TOTAL	17	1	8	22

TENTH SEMESTER

Course code	Course Title	Category	No. of Hours / Week			credits
			L	T	P	
26DSLF0	PROJECT WORK II	EEC	0	0	32	16

Placement support courses (Additional hours)

Semester	Course code	Course Title	Category	No. of Hours / Week			credits
				L	T	P	
1	26CCAA0	VISION AND SPEED MATHS	AC	0	0	2	0
2	26CCAB0	FOUNDATIONS OF PROBLEM SOLVING	AC	0	0	2	0
3	26CCLA0	BUILDING COMMUNICATION SKILLS	EEC	0	0	2	1
4	26CCLB0	NUMERACY SKILLS AND QUANTITATIVE PROBLEM SOLVING	EEC	0	0	2	1
5	26CCLC0	APTITUDE SKILLS	EEC	0	0	4	2

FC : Foundation Course
PCC : Professional Core Course
PEC : Professional Elective Course
EEC : Employability Enhancement Course
AC : Audit Courses

L : Lecture
T : Tutorial
P : Practical

Note:

- **1 Hour Lecture/week is equivalent to 1 credit**
- **1 Hour Tutorial/week is equivalent to 1 credit**
- **2 Hour Practical/week is equivalent to 1 credit**
- **Total credits to be earned for the award of degree: 221**

Thiagarajar College of Engineering, Madurai

Five year Integrated M.Sc (Data Science) Degree Programme

SCHEME OF EXAMINATIONS
(For Students admitted in the Academic Year 2026-2027 onwards)

FIRST SEMESTER

Course code	Course Title	Duration of Terminal Exam. in Hrs.	MARKS			Minimum Pass Marks for 100	
			Continuous Assessment *	Terminal Exam **	Max. Marks	Terminal Exam	Total
THEORY							
26DSKA0	CALCULUS	3	40	60	100	45	50
26DSKB0	DISCRETE STRUCTURES	3	40	60	100	45	50
26DSKC0	DIGITAL ELECTRONICS AND COMPUTER ORGANIZATION	3	40	60	100	45	50
26DSKD0	PROBLEM SOLVING USING C PROGRAMMING	3	40	60	100	45	50
26DSKE0	FOUNDATIONS OF DATA SCIENCE	3	40	60	100	45	50
PRACTICAL							
26DSEA0	C PROGRAMMING LAB	3	60	40	100	45	50
26DSLA0	PROFESSIONAL ENGLISH	3	60	40	100	45	50

SECOND SEMESTER

Course code	Course Title	Duration of Terminal Exam. in Hrs.	MARKS			Minimum Pass Marks for 100	
			Continuous Assessment *	Terminal Exam **	Max. Marks	Terminal Exam	Total
THEORY							
26DSKF0	THEORY OF PROBABILITY	3	40	60	100	45	50
26DSKG0	GRAPH THEORY	3	40	60	100	45	50
26DSCA0	DATA STRUCTURES	3	40	60	100	45	50
26DSCB0	OBJECT ORIENTED PROGRAMMING	3	40	60	100	45	50
26DSCC0	ORGANIZATIONAL THEORY AND BEHAVIOUR	3	40	60	100	45	50
PRACTICAL							
26DSEB0	DATA STRUCTURES LAB	3	60	40	100	45	50
26DSEC0	OBJECT ORIENTED PROGRAMMING USING C++ LAB	3	60	40	100	45	50

THIRD SEMESTER

Course code	Course Title	Duration of Terminal Exam. in Hrs.	MARKS			Minimum Pass Marks for 100	
			Continuous Assessment *	Terminal Exam **	Max. Marks	Terminal Exam	Total
THEORY							
26DSKH0	PARTIAL DIFFERENTIAL EQUATIONS AND TRANSFORMS	3	40	60	100	45	50
26DSCD0	APPLIED STATISTICS	3	40	60	100	45	50
26DSCE0	ADVANCED DATA STRUCTURES	3	40	60	100	45	50
26DSCF0	DATABASE MANAGEMENT SYSTEMS	3	40	60	100	45	50
26DSCG0	OPERATING SYSTEMS	3	40	60	100	45	50
PRACTICAL							
26DSED0	PYTHON PROGRAMMING AND APPLIED STATISTICS LAB	3	60	40	100	45	50
26DSEE0	DATABASE MANAGEMENT SYSTEMS LABORATORY	3	60	40	100	45	50

FOURTH SEMESTER

Course code	Course Title	Duration of Terminal Exam. in Hrs.	MARKS			Minimum Pass Marks for 100	
			Continuous Assessment *	Terminal Exam **	Max. Marks	Terminal Exam	Total
THEORY							
26DSKJ0	LINEAR ALGEBRA FOR DATA SCIENCE	3	40	60	100	45	50
26DSCH0	PREDICTIVE ANALYTICS	3	40	60	100	45	50
26DSCJ0	DATA MINING	3	40	60	100	45	50
26DSCK0	DESIGN AND ANALYSIS OF ALGORITHMS	3	40	60	100	45	50
26DSCL0	SOFTWARE ENGINEERING	3	40	60	100	45	50
PRACTICAL							
26DSEF0	PREDICTIVE ANALYTICS LAB	3	60	40	100	45	50
26DSEG0	ALGORITHM IMPLEMENTATION USING JAVA LAB	3	60	40	100	45	50

FIFTH SEMESTER

Course code	Course Title	Duration of Terminal Exam. in Hrs.	MARKS			Minimum Pass Marks for 100	
			Continuous Assessment *	Terminal Exam **	Max. Marks	Terminal Exam	Total
THEORY							
26DSKK0	NUMERICAL METHODS	3	40	60	100	45	50
26DSKL0	OPTIMIZATION TECHNIQUES	3	40	60	100	45	50
26DSCM0	MACHINE LEARNING	3	40	60	100	45	50
26DSCN0	FULL STACK WEB	3	40	60	100	45	50

	TECHNOLOGIES						
26DSCP0	COMPUTER NETWORKS	3	40	60	100	45	50
PRACTICAL							
26DSEH0	FULL STACK WEB DEVELOPMENT LAB	3	60	40	100	45	50
26DSLD0	MINI PROJECT	-	50	50	100	50	50

SIXTH SEMESTER

Course code	Course Title	Duration of Terminal Exam. in Hrs.	MARKS			Minimum Pass Marks for 100	
			Continuous Assessment *	Terminal Exam **	Max. Marks	Terminal Exam	Total
THEORY							
26DSKM0	STOCHASTIC MODEL	3	40	60	100	45	50
26DSCQ0	DEEP LEARNING	3	40	60	100	45	50
26DSCR0	BUSINESS ANALYTICS AND DATA VISUALIZATION	3	40	60	100	45	50
26DSCS0	ETHICS FOR DATA SCIENCE	3	40	60	100	45	50
26DSPX0	PROFESSIONAL ELECTIVE-I	3	40	60	100	45	50
PRACTICAL							
26DSEJ0	DEEP LEARNING LAB	3	60	40	100	45	50
26DSEK0	BUSINESS ANALYTICS AND VISUALIZATION LAB	3	60	40	100	45	50

SEVENTH SEMESTER

Course code	Course Title	Duration of Terminal Exam. in Hrs.	MARKS			Minimum Pass Marks for 100	
			Continuous Assessment *	Terminal Exam **	Max. Marks	Terminal Exam	Total
PROJECT WORK I							
26DSLE0	PROJECT WORK I	-	60	40	100	50	50

EIGHTH SEMESTER

Course code	Course Title	Duration of Terminal Exam. in Hrs.	MARKS			Minimum Pass Marks for 100	
			Continuous Assessment *	Terminal Exam **	Max. Marks	Terminal Exam	Total
THEORY							
26DSCT0	REINFORCEMENT LEARNING	3	40	60	100	45	50
26DSCU0	NATURAL LANGUAGE PROCESSING	3	40	60	100	45	50
26DSCV0	BIG DATA SYSTEMS	3	40	60	100	45	50
26DSPX0	PROFESSIONAL ELECTIVE-II	3	40	60	100	45	50
26DSPX0	PROFESSIONAL ELECTIVE-III	3	40	60	100	45	50
PRACTICAL							
26DSEL0	NATURAL LANGUAGE PROCESSING LAB	3	60	40	100	45	50
26DSEM0	BIG DATABASE SYSTEMS LAB	3	60	40	100	45	50

NINTH SEMESTER

Course code	Course Title	Duration of Terminal Exam. in Hrs.	MARKS			Minimum Pass Marks for 100	
			Continuous Assessment *	Terminal Exam **	Max. Marks	Terminal Exam	Total
THEORY							
26DSCW0	WEB ANALYTICS	3	40	60	100	45	50
26DSCX0	GENERATIVE AI	3	40	60	100	45	50
26DSCY0	COMPUTER VISION	3	40	60	100	45	50
26DSPX0	PROFESSIONAL ELECTIVE-IV	3	40	60	100	45	50
26DSPX0	PROFESSIONAL ELECTIVE-V	3	40	60	100	45	50
PRACTICAL							
26DSEN0	WEB ANALYTICS LAB	3	60	40	100	45	50
26DSEP0	MATHEMATICAL COMPUTING USING R PROGRAMMING LAB	3	60	40	100	45	50

TENTH SEMESTER

Course code	Course Title	Duration of Terminal Exam. in Hrs.	MARKS			Minimum Pass Marks for 100	
			Continuous Assessment *	Terminal Exam **	Max. Marks	Terminal Exam	Total
PROJECT WORK II							
26DSLF0	PROJECT WORK II	-	60	40	100	50	50

*** Continuous Assessment (CA) evaluation pattern will differ from subject to subject and for different tests. This will have to be declared in advance to students. The Department will put a process in place to ensure that the actual test paper follows the declared pattern.**

**** Terminal Examination for theory courses will be conducted for a maximum mark of 100 and subsequently be reduced to 60 marks for the award of terminal examination marks.**

**** Terminal Examination for laboratory courses will be conducted for a maximum mark of 100 and subsequently be reduced to 40 marks for the award of terminal examination marks**

**** Terminal viva voce for Mini Project will be conducted for a maximum mark of 100 and subsequently be reduced to 50 marks for the award of terminal examination marks**

**** Terminal viva voce for Project work I and II will be conducted for a maximum mark of 100 and subsequently be reduced to 50 marks for the award of terminal examination marks**

Thiagarajar College of Engineering, Madurai – 625 015
Department of Applied Mathematics and Computational Science
Five Year Integrated M.Sc (Data Science) Degree Programme [2026-2027 onwards]
Scheduling of Courses

	Theory					Placement support	Practical		Credits
1	26DSKA0 CALCULUS 3:1 FC	26DSKB0 DISCRETE STRUCTURES 3:1 FC	26DSKC0 DIGITAL ELECTRONICS AND COMPUTER ORGANIZATION 4:0 FC	26DSKD0 PROBLEM SOLVING USING C PROGRAMMING 4:0 FC	26DSKE0 FOUNDATIONS OF DATA SCIENCE 3:0 FC	26CCAA0 VISION AND SPPED MATHS 0:0 AC	26DSEA0 C PROGRAMMING LAB 0:2 FC	26DSLA0 PROFESSIONAL ENGLISH 0:3 EEC	24
2	26DSKF0 THEORY OF PROBABILITY 3:1 FC	26DSKG0 GRAPH THEORY 3:1 FC	26DSCA0 DATA STRUCTURES 4:0 PCC	26DSCB0 OBJECT ORIENTED PROGRAMMING 4:0 PCC	26DSCC0 ORGANIZATIONAL THEORY AND BEHAVIOR 3:0 PCC	26CCAB0 FOUNDATIONS OF PROBLEM SOLVING 0:0 AC	26DSEB0 DATA STRUCTURES LAB 0:3 PCC	26DSEC0 OBJECT ORIENTED PROGRAMMING USING C++ LAB 0:2 PCC	24
3	26DSKH0 PARTIAL DIFFERENTIAL EQUATIONS AND TRANSFORMS 3:1 FC	26DSCD0 APPLIED STATISTICS 3:1 PCC	26DSCE0 ADVANCED DATA STRUCTURES 4:0 PCC	26DSCF0 DATABASE MANAGEMENT SYSTEMS 4:0 PCC	26DSCG0 OPERATING SYSTEMS 3:0 PCC	26CCLA0 BUILDING COMMUNICATION SKILLS 1:0 EEC	26DSED0 PYTHON PROGRAMMING AND APPLIED STATISTICS LAB 0:3 PCC	26DSEE0 DATABASE MANAGEMENT SYSTEMS LABORATORY 0:2 PCC	25
4	26DSKJ0 LINEAR ALGEBRA FOR DATA SCIENCE 3:1 FC	26DSCH0 PREDICTIVE ANALYTICS 3:1 PCC	26DSCJ0 DATA MINING 3:1 PCC	26DSCK0 DESIGN AND ANALYSIS OF ALGORITHMS 4:0 PCC	26DSCL0 SOFTWARE ENGINEERING 3:0 PCC	26CCLB0 NUMERACY SKILLS AND QUANTITATIVE PROBLEM SOLVING 1:0 EEC	26DSEF0 PREDICTIVE ANALYTICS LAB 0:2 PCC	26DSEG0 ALGORITHM IMPLEMENTATION USING JAVA LAB 0:3 PCC	25
5	26DSKK0 NUMERICAL METHODS 3:1 FC	26DSKL0 OPTIMIZATION TECHNIQUES 3:1 FC	26DSCM0 MACHINE LEARNING 3:1 PCC	26DSCN0 FULL STACK WEB TECHNOLOGIES 4:0 PCC	26DSCP0 COMPUTER NETWORKS 3:0 PCC	26CCLC0 APTITUDE SKILLS 2:0 EEC	26DSEH0 FULL STACK WEB DEVELOPMENT LAB 0:2 PCC	26DSLD0 MINI PROJECT 0:2 EEC	25
6	26DSKM0 **STOCHASTIC MODEL** 3:1 FC	26DSCQ0 DEEP LEARNING 4:0 PCC	26DSCR0 BUSINESS ANALYTICS AND DATA VISUALIZATION 4:0 PCC	26DSCS0 ETHICS FOR DATA SCIENCE 3:0 PCC	26DSPX0 PROFESSIONAL ELECTIVE-I 3:0 PEC		26DSEJ0 DEEP LEARNING LAB 0:2 PCC	26DSEK0 BUSINESS ANALYTICS AND VISUALIZATION LAB 0:2 PCC	22
7	26DSLE0 PROJECT WORK I - 0:16								16
8	26DSCT0 REINFORCEMENT LEARNING 4:0 PCC	26DSCU0 NATURAL LANGUAGE PROCESSING 3:1 PCC	26DSCV0 BIG DATA SYSTEMS 4:0 PCC	26DSPX0 PROFESSIONAL ELECTIVE-II 3:0 PEC	26DSPX0 PROFESSIONAL ELECTIVE-III 3:0 PEC	-	26DSEL0 NATURAL LANGUAGE PROCESSING LAB 0:2 PCC	26DSEM0 BIG DATABASE SYSTEMS LAB 0:2 PCC	22
9	26DSCW0 WEB ANALYTICS 4:0 PCC	26DSCX0 **GENERATIVE AI** 4:0 PCC	26DSCY0 COMPUTER VISION 3:1 PCC	26DSPX0 PROFESSIONAL ELECTIVE – IV 3:0 PEC	26DSPX0 PROFESSIONAL ELECTIVE – V 3:0 PEC	-	26DSEN0 WEB ANALYTICS LAB 0:2 PCC	26DSEP0 MATHEMATICAL COMPUTING USING R PROGRAMMING LAB 0:2 PCC	22
10	26DSLF0 PROJECT WORK II - 0:16								16
								Total Credits	221

FC- Foundation Course ; PCC – Programme Core Course ; PEC – Programme Elective Course; EEC – Employability Enhancement Course; AC – Audit Course;

		Category	L	T	P	Credit
26DSKA0	**CALCULUS**	FC	3	1	0	4

Preamble

This course helps students to understand how functions (with one variable and many variables) behave so they can solve complex data science problems. It also teaches how to use multiple integrals to solve real-life problems. In addition, students will learn about sequences and series and how they are used in technical situations.

Prerequisite

- NIL

Course Outcomes

On the successful completion of the course, students will be able to

No.	Course Outcome	TPS Level	Performance Indicator	CO Weightage	SDG addressed	SDG Level	PSOs
CO1	Explain the concept of Differentiation and Integration.	2	1.1.1	10	4	1	1
CO2	Apply maxima and minima techniques for multivariable functions and constrained optimization using Lagrange multipliers.	3	1.1.1	20	9	2	1, 2
CO3	Solve second and higher order Differential equations by using suitable methods.	3	1.1.1	20	9	2	1, 2
CO4	Use the concept of double integration to calculate the general area.	3	1.1.1	15	9	2	1
CO5	Use the triple integral approach to determine the general volume for the provided integrations.	3	1.1.1	15	9	2	1, 2
CO6	Apply sequences and series to data science challenges by using different types of tests.	3	1.1.1	20	9	2	1, 2

Assessment Pattern

CO	CAT1	Assignment 1	CAT2	Assignment 2	Terminal Exam
	% of Marks	% of Marks	% of Marks	% of Marks	% of Marks
CO1	20	20	-	-	10
CO2	40	40	-	-	20
CO3	40	40	-	-	20
CO4	-	-	30	30	15
CO5	-	-	30	30	15
CO6	-	-	40	40	20
Total	100	100	100	100	100

Syllabus

LIMITS AND CONTINUITY: Differentiation **-** Function of single variable – Limit, continuity, periodic. Integration - Absolutely integral, fundamental theorem of calculus.

FUNCTIONS OF TWO VARIABLES: Partial derivative, total derivatives. Taylor series about a point. Stationary points – maxima, minima and saddle points. Constrained maxima and minima – Lagrange's multipliers method.

ORDINARY DIFFERENTIAL EQUATIONS: Linear Differential Equations of first order - Exact differential equations, Integrating factors, Bernoulli equations. Linear Differential Equations of second and higher order with constant coefficients and variable coefficients – Euler's and Legendre's type. Simultaneous equations with constant Co-efficient, Method of variation of parameters.

MULTIPLE INTEGRALS: Double integrals in Cartesian form - Change of order of integration – Double integrals in polar form. Triple integrals in Cartesian form - Change of variable in triple integrals into polar, spherical and cylindrical co-ordinates.

SEQUENCES AND SERIES: Infinite Sequences – convergence, divergence. Infinite Series – convergence and divergence, comparison test, integral test, ratio test, root test. Alternating series – alternating series test, absolute and conditional convergence, Power series.

Text Book

1. J.R. Hass, C.E. Heil, P. Bogacki, M.D. Weir, "Thomas Calculus", Pearson Education,15th edition, 2023.
2. James Stewart, Daniel K. Clegg, Saleem Watson, "Single Variable Calculus", Cengage Learning, 9th edition, 2021.

Reference Books & web resources

1. Lian, Hungerford, and Holcomb "Mathematics with Applications", Addison Wesley, 2010.
2. Michael D. Greenberg, "Advanced Engineering Mathematics", Pearson Education, 2013.
3. Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley & Sons, 2014.
4. http://calculus.org
5. https://www.khanacademy.org/math/calculus-1
6. https://dlmf.nist.gov
7. https://www.siam.org/
8. NPTEL course on "Advanced Calculus for Engineers, IIT Kharagpur https://nptel.ac.in/courses/111105160

SDG Alignment

Activities aligned with SDGs addressed:

1. Differentiation and integration improve analytical and problem-solving skills, supporting quality mathematical education and strong foundational learning. (SDG 4 – Quality Education)

2. Partial derivatives, differential equations, double and triple integrals, sequences, and series support real-world modelling, area and volume analysis, data science, and computational methods, contributing to technological innovation and industrial development. (SDG 9 – Industry, Innovation and Infrastructure).

Course Contents and Lecture Schedule

Module No.	Topic	No. of Periods
1	**Limits and Continuity**	
1.1	Differentiation **-** Function of single variable	2
1.2	Limit, continuity, periodic functions.	2
1.3	Integration – Absolutely integral, fundamental theorem of calculus.	2
2	**Functions of Two Variables**	
2.1	Partial derivative, total derivatives, Taylor series about a point.	4
2.2	Stationary points – maxima, minima and saddle points.	2
2.3	Constrained maxima and minima – Lagrange's multipliers method.	2
3	**Ordinary Differential Equations**	
3.1	Linear Differential Equations of first order - Exact differential equations, Integrating factors, Bernoulli equations.	3
3.2	Linear Differential Equations of second and higher order with constant coefficients and variable coefficients	2
3.3	Euler's and Legendre's type.	2
3.4	Simultaneous equations with constant Co-efficient, Method of variation of parameters.	3
4	**Multiple Integrals**	
4.1	**Double Integrals**: Double integrals in Cartesian form	3
4.2	Change of order of integration	2
4.3	Double integrals in polar form	2
4.4	**Triple Integrals:** Triple integrals in Cartesian form	3
4.5	Change of variable in triple integrals into polar	2
4.6	Spherical and cylindrical co-ordinates. Applications of multiple integrals	3
5	**Sequences and Series**	
5.1	Infinite Sequences – convergence, divergence.	3
5.2	Infinite Series – convergence and divergence, comparison test, integral test, ratio test, root test.	3
5.3	Alternating series – alternating series test, absolute and conditional convergence, and Power series.	3
	Total	48

Course Designer(s):

Dr. B. Surya Devi, bsdca@tce.edu
Assistant Professor in Data science,
Dept. of Applied Mathematics and Computational Science
Thiagarajar College of Engineering.

26DSKB0 DISCRETE STRUCTURES

Category	L	T	P	Credits
FC	3	1	0	4

Preamble

This course develops analytical and computational skills through logic, relations, combinatorics, and automata theory, enabling students to learn the basic concepts of algebraic structures and groups, apply the concepts of normal subgroups and group homohorphism.

Prerequisite

- Nil

Course Outcomes

On the successful completion of the course, students will be able to

No.	Course Outcome	TPS Level	Performance Indicator	CO Weightage	SDG addressed	SDG Level	PSOs
CO1	Apply logical reasoning techniques to prove implications, derive PCNF and PDNF.	3	1.1.1	20	4	1	1
CO2	Apply predicates and symbolic logic to construct and validate arguments.	3	1.1.1	20	4	1	1
CO3	Apply discrete mathematical structures to computational problem solving.	3	1.1.1	10	4	0	1
CO4	Apply mathematical induction, permutations, and combinations to solve problems.	3	1.1.1	15	4	1	1
CO5	Apply the concepts of Groups, subgroups and its properties with Permutation	3	1.1.1	15	9	1	1, 2
CO6	Apply the concept of groups to learn about normal subgroups and fundamental theorem of group homomorphism	3	1.1.1	20	9	1	1, 2

Assessment Pattern

CO	CAT1	Assignment 1	CAT2	Assignment 1	Terminal Exam
	% of Marks	% of Marks	% of Marks	% of Marks	% of Marks
CO1	40	30	-		20
CO2	40	35	-		20
CO3	20	35	-		10
CO4	-		30	30	15
CO5	-		30	35	15
CO6	-		40	35	20
Total	**100**	**100**	**100**	**100**	**100**

Syllabus

Module 1 – Mathematical logic:
Propositional Calculus: Statements and Notations, Connectives, Well Formed Formulas, Truth Tables, Tautologies, Equivalence of Formulas, Duality Law, Tautological Implications, Normal Forms, Theory of Inference for Statement Calculus, Consistency of Premises, Indirect Method of Proof.

Module 2 – Predicate Calculus:
Predicates - Statement Function, Variables and Quantifiers, Theory of inferences of Predicate Calculus.

Module 3 – Functions & Relations:
Functions: Bijective Functions, Composition of Functions, Inverse Functions, Permutation Functions, Recursive Functions,
Relations: Binary relations, Equivalence relations and Partitions, Matrix representation of a relation, relation representation by graphs. Partially ordered set (PO Set), Hasse Diagram, LUB, GLB.

Module 4 – Mathematical Induction & Combinatorics:
Mathematical Induction. Basics of Counting. Permutations and Combinations. Recurrence relations. Principle of Inclusion and Exclusion.

Module 5 – Groups & Subgroups:
Groups - Definition and Example, Properties of Groups, Permutation Groups, Symmetric Groups, Subgroups, Cyclic Groups, Cosets and Lagrange's theorem, Normal subgroups

Module 6 – Group Homorphism
Homomorphism, Isomorphism, Automorphism, Cayley's theorem, Factor group, Fundamental theorem of group homomorphism.

Text Book

1. Kenneth H. Rosen, "Discrete mathematics and its applications", McGraw-Hill International Editions, 2021.
2. John E. Hopcraft, Rajeev Motwani, Jeffery D. Ullman, "Introduction to Automata Theory, Languages and Computation", Pearson Education, Asia, 3rd edition, 2013.

Reference Books & web resources

1. Trembly and Manohar, "Discrete mathematical structures with applications to Computer Science", Tata McGraw-Hill, 2017.
2. Judith L. Gersting, "Mathematical Structures for Computer Science", W.H. Freeman and Company, 2014.
3. Michael D. Greenberg, "Advanced Engineering Mathematics", Pearson Education, 2014.
4. MIT OpenCourseWare – 6.042J | Fall 2010 | Undergraduate, https://ocw.mit.edu/courses/6-042j-mathematics-for-computer-science-fall-2010/video_galleries/video-lectures/
5. NPTEL – Theory of Automata, Formal Languages and Computation, IIT Madras https://nptel.ac.in/courses/106106049

SDG Alignment

Activities aligned with SDGs addressed:

1. Applying logical reasoning, mathematical proof techniques, relations, and combinatorial methods to develop analytical and problem-solving skills for mathematics and computing applications. (SDG 4 – Quality Education)
2. Utilizing algebraic structures and group-theoretic concepts in cryptography, coding theory, and computational models to foster innovation and technological advancement. (SDG 9 – Industry, Innovation and Infrastructure)

Course Contents and Lecture Schedule

Module No.	Topic	No. of Periods
1	**Mathematical logic**	
1.1	Propositional Calculus: Statements and Notations, Connectives, Well Formed Formulas	2
1.2	Truth Tables, Tautologies, Equivalence of Formulas, Duality Law, Tautological Implications.	2
1.3	Normal Forms, Theory of Inference for Statement Calculus	2
1.4	Consistency of Premises, Indirect Method of Proof.	1
2	**Predicate Calculus**	
2.1	Predicates - Statement Function,	2
2.2	Variables and Quantifiers,	2
2.3	Theory of inferences of Predicate Calculus.	2
3	**Functions & Relations**	
3.1	Bijective Functions, Composition of Functions - Problems	1
3.2	Inverse Functions, Permutation Functions, Recursive Functions – Problems	2
3.3	Relations: Relations, Binary relations, Equivalence relations and Partitions	2
3.4	Matrix representation of a relation, relation representation by graphs.	2
3.5	Partially ordered set (PO Set)	1
3.6	Hasse Diagram, LUB, GLB	2
4	**Mathematical Induction & Combinatorics**	
4.1	Mathematical Induction. Basics of Counting.	2
4.2	Permutations and Combinations - Problems	1
4.3	Recurrence relations - Problems	2
4.4	Principle of Inclusion and Exclusion - Problems	2
5	**Groups & Subgroups**	
5.1	Groups - Definition and Example, Properties of Groups	2
5.2	Permutation Groups, Symmetric Groups	2
5.3	Subgroups, Cyclic Groups	2
5.4	Cosets and Lagrange’s theorem	2
5.5	Normal subgroups	2
6	**Group Homorphism**	

Module No.	Topic	No. of Periods
6.1	Homomorphism, Isomorphism	3
6.2	Automorphism, Cayley's theorem	2
6.3	Factor group, Fundamental theorem of group homomorphism.	3
	Total Periods	**48**

Course Designer(s):

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Applied Mathematics and Computational Science
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26DSKC0	DIGITAL ELECTRONICS AND COMPUTER ORGANIZATON	Category	L	T	P	Credit
		FC	4	0	0	4

Preamble

This course introduces the fundamentals of digital systems and computer organization used in modern computing. It helps students understand how data is represented, processed, stored, and communicated inside a computer system. The course also provides basic knowledge of processor architecture, memory organization, and parallel computing concepts relevant to Data Science and AI applications.

Prerequisite

- Nil

Course Outcomes

On the successful completion of the course, students will be able to

No.	Course Outcome	TPS Level	Performance Indicator	CO Weightage	SDG Addressed	SDG Level	PSOs
CO1	Apply digital data representation, Boolean algebra, and logic gate operations in computing systems	3	1.3.1	20	4	3	1
CO2	Design combinational and sequential circuits using standard digital components and simulation tools	3	5.1.1	20	9	3	1,2
CO3	Explain processor organization, instruction execution, addressing modes and arithmetic operations.	2	2.1.1	15	9	2	1,2
CO4	Apply memory hierarchy, cache organization, and storage mechanisms for efficient data processing	3	2.2.2	20	7	4	2
CO5	Apply input/output organization and storage performance metrics in computing systems	3	1.4.1	15	9	3	2
CO6	Explain basic parallel computing concepts including pipelining, RISC/CISC and multicore processors	2	5.1.1	10	9	2	2

Assessment Pattern

CO	CAT1	Assignment 1	CAT2	Assignment 2	Terminal Exam
	% of Marks	% of Marks	% of Marks	% of Marks	% of Marks
CO1	35	50	-	-	20
CO2	35	50	-	-	20
CO3	30	-	-	-	15
CO4	-	-	40	50	20

CO5	-	-	40	50	15
CO6	-	-	20	-	10
Total	100	100	100	100	100

Syllabus

Digital Data Representation and Logic Fundamentals: Introduction to Digital Systems and Data Representation in computing systems - Number systems: Binary, Octal, Decimal, Hexadecimal, BCD, Gray Code and conversions. - Signed Number Representation (1's Complement, 2's Complement) - Binary Arithmetic (Addition, Subtraction, Overflow) - Boolean Algebra and logic simplification – K-Map Simplification Techniques - Logic Gates and Universal Gates (AND, OR, NOT, NAND, NOR, XOR, XNOR).

Combinational and Sequential Logic Design: Combinational circuit design - Adders (Half Adders and Full Adders) - Multiplexers and De Multiplexers - Encoders and Decoders – Flip-Flops (SR, JK, D and T Flip-Flops) and Registers (Shift Registers, Serial In Serial Out, Serial In Parallel Out, Parallel In, Parallel Out) - Counters (Ripple Counter, Synchronous Counter, Up/Down Counter).

Processor Organization and Instruction Execution: Functional units of a computer - CPU organization - Instruction cycle (Fetch, Decode and Execute) - Instruction formats and Addressing modes - Arithmetic and Logic Unit (ALU) Operations - Fixed-point arithmetic operations - Floating-point representation basics - Control unit organization - Hardwired and microprogrammed control.

Memory Systems and Storage Organization: Memory Hierarchy and Characteristics - Primary Memory (RAM, ROM) & Secondary Storage Organization - Cache Memory & Cache Mapping Techniques (Direct, Associative and Set Associative Mapping) - Virtual memory - Performance metrics: latency, throughput, hit ratio.

Input and Output Organization: Basic I/O organization – Accessing I/O Devices – Interrupts –Direct Memory Access (DMA).

Parallel and High-Performance Computing Architectures: Pipelining concepts – Reduced Instruction Set Computer (RISC) - Complex Instruction Set Computer (CISC) architecture - Multicore processors – GPU Architecture.

Text Book

1. M. Morris Mano, Michael D. Ciletti, "Digital Design", Pearson Education, 6th Edition, 2018. (Chapter 1-7)
2. Carl Hamacher, Zvonko G. Vranesic, Safwat G. Zaky, "Computer Organization", McGraw Hill Education, 6th Edition, 2012. (Chapter 1-7)

Reference Books & web resources

1. Thomas L. Floyd, "Digital Fundamentals", Pearson Education, 11th Edition, 2015.
2. Andrew S. Tanenbaum, Todd Austin, "Structured Computer Organization", Pearson Education, 6th Edition, 2013.
3. David A. Patterson, John L. Hennessy, "Computer Organization and Design", Morgan Kaufmann Publishers, 5th Edition, 2017. (Chapter 1-6)
4. M. Morris Mano, "Computer System Architecture", Pearson Education, 3rd Edition, 2017.
5. Mostafa Abd-El-Barr, Hesham El-Rewini, "Fundamentals of Computer Organization and Architecture", Wiley India Pvt. Ltd., 2008.

SDG Alignment

Activities aligned with SDG's Addressed:

1. **Mini Activity using logic simulation tools for digital circuit visualization (SGD 4)**
2. **Case study on energy-efficient computing or green data centres (SDG 7)**
3. **Comparative study of CPU, GPU and multicore architectures used in AI systems (SDG 9)**

Course Contents and Lecture Schedule

Module No	Topics	No of Periods
1	**Digital Data Representation and Logic Fundamentals**	
1.1	Introduction to Digital Systems and Data Representation in computing systems	1
1.2	Number Systems – Binary, Octal, Decimal, Hexadecimal, BCD, Gray Code and conversions.	2
1.3	Signed Number Representation – 1's Complement, 2's Complement	1
1.4	Binary Arithmetic (Addition, Subtraction, Overflow)	1
1.5	Boolean Algebra and logic simplification	1
1.6	K-Map Simplification Techniques	2
1.7	Logic Gates and Universal Gates (AND, OR, NOT, NAND, NOR, XOR, XNOR)	1
2	**Combinational and Sequential Logic Design**	
2.1	Combinational circuit design	1
2.2	Adders (Half Adder and Full Adder)	1
2.3	Multiplexers and Demultiplexers	2
2.4	Encoders and Decoders	2
2.5	Flip-Flops (SR, JK, D and T Flip-Flops)	2
2.6	Registers (Shift Registers, Serial In Serial Out, Serial In Parallel Out, Parallel In, Parallel Out)	2
2.7	Counters (Ripple Counter, Synchronous Counter, Up/Down Counter)	1
3	**Processor Organization and Instruction Execution**	
3.1	Functional Units of a Computer, CPU Organization	1
3.2	Instruction Cycle (Fetch, Decode and Execute)	1
3.3	Instruction Formats and Addressing Modes	1
3.4	Arithmetic Logic Unit (ALU) Operations	1
3.5	Fixed Point Arithmetic Operations	1
3.6	Floating Point Representation basics	1
3.7	Control Unit Organization	1
3.8	Hardwired and Microprogrammed Control	2
4	**Memory Systems and Storage Organization**	
4.1	Memory Hierarchy and Characteristics	1
4.2	Primary Memory (RAM, ROM) & Secondary Storage Organization	1
4.3	Cache Memory	1
4.4	Cache Mapping Techniques (Direct, Associative and Set Associative Mapping	2
4.5	Virtual Memory	1
4.5	Performance Metrics – Latency, Throughput and Hit Ratio	1
5	**Input and Output Organization:**	
5.1	Basic I/O organization	1
5.2	Accessing I/O Devices	1
5.3	Interrupts	2
5.4	Direct Memory Access (DMA).	2
6	**Parallel and High-Performance Computing Architectures**	
6.1	Pipelining Concepts	1
6.2	Reduced Instruction Set Computer (RISC) architecture	1
6.3	Complex Instruction Set Computer (CISC) architecture	1
6.4	Multicore processors	1
6.5	GPU Architecture	2
	Total Periods	**48**

Course Designer(s):

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26DSKD0	PROBLEM SOLVING USING C PROGRAMMING	Category	L	T	P	Credit
		FC	4	0	0	4

Preamble

This course aims to develop problem-solving and logical thinking skills using the C programming language. It provides a foundation in basic programming concepts through simple and practical computing problems.

Prerequisite

Nil

Course Outcomes

After the successful completion of the course, students will be able to

No.	Course Outcome	TPS Level	Performance Indicator	CO Weightage	SDG addressed	SDG Level	PSOs
CO1	Apply basic programming constructs to develop algorithms and flowcharts for solving computational problems.	3	1.3.1	10	4	3	1
CO2	Implement operators, expressions, and data types to implement arithmetic and logical operations and control flow statements in C programs solve given computational problems.	3	2.4.1	15	4	3	1
CO3	Develop programs using functions, arrays, and strings for problem solving.	3	2.2.2	15	9	3	2
CO4	Apply pointers, pointer arrays, function pointers, and multidimensional arrays to develop efficient C programs.	3	2.2.2	15	9	3	2
CO5	Use structures and unions to organize and manage complex data in C programming applications.	3	2.2.1	15	8	3	2
CO6	Apply file handling operations to manage data processing in C programs.	3	2.2.2	10	9	3	2

Assessment Pattern

CO	CAT1	Assignment 1	CAT2	Assignment 2	Terminal Exam
	% of Marks	% of Marks	% of Marks	% of Marks	% of Marks
CO1	25	30			10
CO2	35	35			15
CO3	40	35			20
CO4			35	35	20
CO5			35	35	20
CO6			30	30	15
Total	100	100	100	100	100

Syllabus

Designing Efficient Programs – Programming Paradigms- Example of Structured Program- Program Designing tools: Algorithms, flowcharts and Pseudocodes. Types of Errors.

C Fundamentals: The C Character Set, Identifiers and Keywords, Data Types, Constants, Variables and Arrays, Declarations, Expressions Statements, Symbolic Constants

Operators, Expressions, Data Input & Output: Arithmetic, Unary, Relational and logical operators - Type conversions – Increment, Decrement and bitwise operators – Assignment operators and expressions - Conditional operator – Data Input and Output: Single Character input & output- scanf and printf functions- gets and puts functions- Practice problems.

Control flow: Statements and blocks – Decision control structures – Looping control structures - Case control structures – Break and continue – Practice problems

Functions and Program Structure: Basics – Function Prototyping - Function Call by value - Function Call by reference – Recursion – Storage classes- Automatic, External, Static variables- Practice problems

Arrays and strings: Define and processing Array- Passing arrays to Functions- Multidimensional Arrays- Arrays and Strings

Pointers: Basic of pointers- Passing Pointer to Functions- Pointers and one-dimensional arrays- Dynamic Memory Allocation- Operations on Pointers- Pointers and Multidimensional arrays– Arrays of Pointers Practice problems

Structures and Unions: Defining and processing Structures- User-defined data (typedef)– Array of structures – Pointer to structures – Passing structures to Functions-Self-referential structures – Unions – Bit fields - Practice problems

Data files: Opening and Closing a Data File, Reading and Writing data from file– Error handling - Practice problems

Text Book

1. Reema Thareja “Computer fundamentals and programming in C”, Oxford University, Second edition, 2017 [Module 1]
2. Byron S Gottfried, “Programming with C”, McGraw Hill, 4th Edition, 2018. [Module 2 to 10]

Reference Books & web resources

1. Yashavant Kanetkar, “Let Us C: Authentic guide to C programming language” , 18th Edition, BPB Publications, 2021.
2. Sumitabha Das, “Computer Fundamentals and C Programming”, McGraw Hill Education, 2018.
3. Brian W Kernighan & Dennis Ritchie, ”The C programming language”, 2nd Edition, Prentice Hall , 2015.
4. Tutorial: https://www.learn-c.org/

SDG Alignment

Activities aligned with SDGs addressed:

1. Developing simple C programs to solve real-world problems related to education, automation, and data processing, thereby promoting computational thinking and digital literacy. (SDG 4 – Quality Education & SDG 9 – Industry, Innovation and Infrastructure)
2. Implementing programming solutions for efficient data handling and problem-solving applications that enhance employability and technical skill development for industry needs. (SDG 8 – Decent Work and Economic Growth)

Course Contents and Lecture Schedule

Module No	Topics	No of Periods
1	**Designing Efficient Programs**	
1.1	Programming Paradigms- Example of Structured Program	1
1.2	Algorithms, flowcharts and Pseudocodes	2
1.3	Types of Errors	1
2	**C Fundamentals**	
2.2	The C Character Set, Identifiers and Keywords	1
2.3	Data Types, Constants, Variables	2
2.4	Arrays, Declarations	1
2.5	Expressions Statements, Symbolic Constants	1
3	**Operators, Expressions, Data Input & Output**	
3.1	Type conversions – Increment, Decrement and bitwise operators	2
3.2	Arithmetic, Unary, Relational and logical operators	1
3.3	Assignment operators and expressions, Conditional operator	1
3.4	Single Character input & output- scanf and printf functions	1
3.5	gets and puts functions- Practice problems.	1
4	**Control flow**	
4.1	Statements and blocks – Decision control structures	2
4.2	Looping control structures	2
4.3	Case control structures – Break and continue	1
5	**Functions and Program Structure**	
5.1	Basics – Function Prototyping	1
5.2	Function Call by value - Function Call by reference	1
5.3	Recursion	1
5.4	Storage classes- Automatic, External, Static variables	2
6	**Arrays and strings**	
6.1	Define and processing Array	1
6.2	Passing arrays to Functions	1
6.3	Multidimensional Arrays	1
6.4	Arrays and Strings	1
7	**Pointers**	
7.1	Basic of pointers- Passing Pointer to Functions	2

7.2	Pointers and one-dimensional arrays	1
7.3	Dynamic Memory Allocation	1
7.4	Operations on Pointers	1
7.5	Pointers and Multidimensional arrays	2
7.6	Arrays of Pointers Practice problems	1
8	**Structures and Unions**	
8.1	Defining and processing Structures	2
8.2	User-defined data (typedef)– Array of structures	1
8.3	Pointer to structures	1
8.4	Passing structures to Functions	1
8.5	Self-referential structures	1
8.6	Unions – Bit fields	2
9	**Data Files**	
9.1	Opening and Closing a Data File	1
9.2	Reading and Writing data from file	1
9.3	Error handling	1
	Total Periods	**48**

Course Designer(s):

1. Dr.V.Punitha,
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26DSKE0	FOUNDATIONS OF DATA SCIENCE	Category	L	T	P	Credit
		FC	3	0	0	3

Preamble

This course provides a foundation in Data Science, covering data types, the Data Science process, data collection, analytics, and visualization. It introduces techniques for handling structured and unstructured data, exploratory analysis, modelling, and evaluation, while emphasizing ethical issues, Big Data concepts, and practical data-driven problem solving.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course, students will be able to

No.	Course Outcome	TPS Level	Performance Indicator	CO Weightage	SDG Addressed	SDG Level	PSOs
CO1	Explain the fundamental concepts, applications, ecosystem, and ethical issues related to Data Science and Big Data	2	1.6.1	15	4	1	1
CO2	Explain different data types, structures, sources, and formats used in Data Science applications	2	1.4.1	15	9	2	1,2
CO3	Apply the stages involved in the Data Science process, including data collection, pre-processing, exploratory analysis, modelling, and evaluation.	3	1.4.1, 2.1.3	15	9	2	1,2
CO4	Apply suitable data collection, pre-processing, and analytical techniques used for solving basic data-driven problems	3	2.4.1	15	9	2	1,2
CO5	Apply descriptive, exploratory, diagnostic,	3	2.4.1, 5.1.1	20	9	3	2

	predictive, prescriptive, and mechanistic analytics techniques to derive meaningful insights from data						
CO6	Apply suitable data visualization and interpretation techniques to effectively communicate analytical findings using Data Science tools	3	5.1.1, 10.1.1	20	4	3	1,2

Assessment Pattern

CO	CAT1	Assignment 1	CAT2	Assignment 2	Terminal Exam
	% of Marks	% of Marks	% of Marks	% of Marks	% of Marks
CO1	30	-	-	-	15
CO2	30	-	-	-	15
CO3	40	60	-	-	15
CO4	-	40	30	30	15
CO5	-	-	30	30	20
CO6	-	-	40	40	20
Total	100	100	100	100	100

Syllabus

Foundations of Data Science: What is Data Science? – Benefits and Uses of Data Science and Big Data – Where Do We See Data Science? – How Does Data Science Relate to Other Fields? – The Relationship between Data Science and Information Science – Computational Thinking – Skills for Data Science – Tools for Data Science – Issues of Ethics, Bias, and Privacy in Data Science – The Big Data Ecosystem and Data Science.

Introduction to Data: Data Types– Facets of Data – Structured Data – Unstructured Data – Natural Language – Machine-Generated Data – Graph-Based Data – Audio, Image and Video Data – Streaming Data - Open Data - Social Media Data - Multimodal Data – Data Storage and Presentation – Challenges with Unstructured Data.

Introduction to Data Science Process: Overview of the Data Science Process – Defining Research Goals and Problem Formulation– Retrieving Data – Cleansing, Integrating, and Transforming Data – Exploratory Data Analysis (EDA) – Build the Models – Model Evaluation.

Data Collection: Introduction - Data Collection Methods - Picking Data Collection and Analysis Methods - Evaluation.

Data Analytics: Introduction to Data Analysis and Data Analytics – Descriptive Analysis: Variables, Frequency Distribution, Measures of Centrality, Dispersion of a Distribution – Exploratory Analysis: Insights from Visual Patterns, Distribution of Data, Trends Over Time, Relationships Between Variables, Categorical Comparisons, Anomalies and Outliers – An

Overview of Diagnostic Analytics: Correlation – Predictive Analytics – Prescriptive Analytics – Mechanistic Analysis

Data Visualization: Importance of Data Visualization – Visual Exploration of Data – Plot Types (Scatterplot, Histogram, Heat Map, Bar/Line Charts) – Case Study on Visualizing a real data problem.

Text Books

1. Chirag Shah, "A Hands-On Introduction to Data Science", Cambridge University Press, 2022.
   (Chapters: 1.1 – 1.6, 2.2-2.3, 3.1 – 3.8, 11, 12)
2. Cielen D., Meysman A. D. B., Ali M., "Introducing Data Science", Manning Publications, Reprint Edition, 2023.
   (Chapters: 1.2, 2.1 – 2.7. 9.1 – 9.4)
3. Kotu V., Deshpande B., "Data Science: Concepts and Practice", Morgan Kaufmann, 2nd Edition, 2018.
   (Chapter: 3.4)

Reference Books & web resources

1. Grus J., "Data Science from Scratch: First Principles with Python", O'Reilly Media, 2nd Edition, 2019.
2. Ozdemir S., "Principles of Data Science", Packt Publishing, 2nd Edition, 2024.
3. Peng R. D., Matsui E., "The Art of Data Science", Lean Publishing, 2020.
4. Wagh S. J., Bhende M. S., Thakare A. D., "Fundamentals of Data Science", CRC Press, 1st Edition, 2022.
5. https://www.ibm.com/topics/data-science
6. https://learn.microsoft.com/en-us/training/paths/introduction-data-science
7. https://scikit-learn.org/stable/documentation.html
8. https://towardsdatascience.com/

SDG Alignment

Activities aligned with SDGs addressed:

1. Open-data exploration activity (SDG 9 — Industry, Innovation and Infrastructure, Level 2): students locate and characterize an open dataset (e.g., government open-data portal), classify its facets and structure, and report on storage/integration challenges — linked to Module 2.
2. End-to-end Data Science process mini-project (SDG 9 — Industry, Innovation and Infrastructure, Level 3): students take a small data problem from research-goal definition through retrieval, cleansing, EDA, modelling and evaluation — linked to Modules 3 and 5.
3. Analytics case study on a public-interest dataset (SDG 9 — Industry, Innovation and Infrastructure, Level 3; with optional SDG 3, 11 or 13 framing): students apply descriptive, diagnostic and predictive analytics to a dataset drawn from healthcare, urban services, or climate (their choice), and report the insights — linked to Modules 4, 5 and 6.
4. Data-visualization explainer (SDG 4 — Quality Education, Level 2): students prepare a short visual explainer (using appropriate plot types) of a Data Science concept or result for a general-learner audience, released as an open educational resource — linked to Module 6.

Course Contents and Lecture Schedule

Module No	Topics	No.of Periods
1	**Foundations of Data Science**	
1.1	What is Data Science? – Benefits and Uses of Data Science and Big Data	1
1.2	Where Do We See Data Science?	1
1.3	How Does Data Science Relate to Other Fields? – The Relationship between Data Science and Information Science	1
1.4	Computational Thinking	1
1.5	Skills for Data Science – Tools for Data Science	1
1.6	Issues of Ethics, Bias, and Privacy in Data Science	1
1.7	The Big Data Ecosystem and Data Science	1
2	**Introduction to Data**	
2.1	Data Types – Facets of Data	1
2.2	Structured Data – Unstructured Data	1
2.3	Natural Language – Machine-Generated Data	1
2.4	Graph-Based Data – Audio, Image and Video Data	1
2.5	Streaming Data - Open Data - Social Media Data	1
2.6	Multimodal Data – Data Storage and Presentation	1
2.7	Challenges with Unstructured Data	1
3	**Introduction to Data Science Process**	
3.1	Overview of the Data Science Process	1
3.2	Defining Research Goals and Problem Formulation	1
3.3	Retrieving Data	1
3.4	Cleansing, Integrating, and Transforming Data	1
3.5	Exploratory Data Analysis (EDA)	1
3.6	Build the Models – Model Evaluation	1
4	**Data Collection**	
4.1	Introduction - Data Collection Methods	1
4.2	Picking Data Collection and Analysis Methods	2
4.3	Evaluation	1
5	**Data Analytics**	
5.1	Introduction to Data Analysis and Data Analytics	1
5.2	Descriptive Analysis: Variables, Frequency Distribution, Measures of Centrality, Dispersion of a Distribution	1
5.3	Exploratory Analysis: Insights from Visual Patterns, Distribution of Data, Trends Over Time	2
5.4	Relationships Between Variables, Categorical Comparisons, Anomalies and Outliers	2
5.5	An Overview of Diagnostic Analytics: Correlation	1
5.6	Predictive Analytics – Prescriptive Analytics – Mechanistic Analysis	1
6	**Data Visualization**	
6.1	Importance of Data Visualization	1
6.2	Visual Exploration of Data	1
6.3	Plot Types: Scatterplot, Histogram, Heat Map, Bar/Line Charts	1
6.4	Case Study on Visualizing a Real Data Problem	1
Total		**36**

Course Designer(s):

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2. Mr.B.Johnson , bjnds@tce.edu
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		Category	L	T	P	Credit
26DSEA0	**C PROGRAMMING LAB**	FC	0	0	4	2

Preamble

The course aims to provide exposure to problem-solving through C programming and involves a lab component which is designed to give the student hands-on experience with the concepts.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course, students will be able to

No.	Course Outcome	TPS Level	Performance Indicator	Objective	SDG Addressed	SDG Level	PSOs
CO1	Implement C programs using suitable data types and control structures to solve computational problems.	3	2.4.1	Problem Solving	4	3	1
CO2	Develop modular C programs using user-defined and recursive functions for solving programming problems.	3	5.1.1	Experimentation	8	2	1,2
CO3	Use single and multidimensional arrays to implement searching, sorting, and matrix operations in C programs.	3	1.3.1	Creativity	9	2	1
CO4	Implement C programs demonstrating pointer concepts and dynamic memory handling techniques.	3	5.2.1	Efficient Memory Management	9	3	1,2
CO5	Develop C programs using structures and unions to manage and organize complex data efficiently.	3	5.2.1	Data Organization	9	2	1,2
CO6	Develop and document file handling programs by following ethical coding practices and proper report preparation standards.	3	5.1.1	Reporting, Ethics and Communication	8	2	1,2

Assessment Pattern

Type of Assessment	Component	Marks	Remarks
Continuous Assessment	Pre-lab, In-lab, Post-lab	75	Conducted throughout the semester
Model Test	CO-wise (Cognitive, Psychomotor, Affective)	25	Mid / End semester internal test
Total Internal Marks		**100**	
End Semester Examination	CO-wise (Cognitive, Psychomotor, Affective)	100	As directed by COE or as per curriculum

List of Experiments with CO Mapping

Sl. No.	Name of the Experiment	Level of Experiment	COs Addressed
1	Programs to demonstrate data types, variables, storage classes, operators, and expressions in C	2	1
2	Implementation of conditional and looping statements for solving computational problems	2	1, 2
3	Programs using user-defined functions and recursive functions	2	1, 2
4	Programs to implement searching and sorting using single-dimensional arrays and functions	2	2,3
5	Programs for matrix operations using multidimensional arrays and functions	2	1,2,3
6	Programs to perform string manipulation using arrays and functions	2	2,3
7	Implementation of structures, arrays of structures, and unions	2	2,3,4
8	Programs demonstrating pointer operations, pointer arithmetic, and pointers with functions	2	4,5
9	Implementation of dynamic memory allocation using pointers and structures	2	5,6
10	Creating and processing data files using file handling functions and structures	2	5,6

Reference Books & web resources

1. Byron S Gottfried,"Programming with C", McGraw Hill, 4th Edition, 2018
2. Yashavant Kanetkar, "Let Us C: Authentic guide to C programming language", 18th Edition, BPB Publications, 2021
3. Sumitabha Das, "Computer Fundamentals and C Programming", McGraw Hill
4. Tutorial: https://www.learn-c.org/

Course Designer:

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		Category	L	T	P	Credit
26DSLA0	**PROFESSIONAL ENGLISH**	EEC	0	2	2	3

Preamble

The course is designed to enable students to apply language competencies and communication skills effectively in the digital era. It aims to foster critical thinking, professional communication, and collaborative abilities essential for success in career.

Prerequisite

NIL

Course Outcomes

After the successful completion of the course, students will be able to

No.	Course Outcome	TPS Level	Performance Indicator	CO Weightage	SDG addressed	SDG Level
CO1	Explain the significance of listening, speaking, reading, and writing skills in technical and non-technical contexts.	TPS2	9.1.1	20%	4	1
CO2	Apply effective listening and speaking strategies for discussions and workplace interactions.	TPS3	8.2.1	25%	4	1
CO3	Use appropriate grammar, vocabulary, and professional writing conventions to create technical and workplace documents.	TPS3	9.1.2	30%	4	1
CO4	Analyze technical texts, data-oriented articles, and professional communication scenarios to interpret ideas and communicate insights effectively.	TPS4	9.3.1	25%	4	1

Assessment Pattern

Internal

No Common Continuous Assessment Test (CAT) will be conducted.
Students' performance will be continuously assessed in various classroom activities on Listening, Speaking, Reading and Writing for 50 marks as detailed below

Listening Test – 10 CO1
Speaking Test- JAM (05), Self -Introduction – (10), Team meeting simulation (10) – 20 CO2
Written Test (Basic Grammar, Email writing, Technical Report writing, Reading) – 20 CO3 & CO4

External (Practical)

Listening – 20 CO1
Self – Introduction – 10 CO2
Speaking (Work place Simulation) – 20 CO2
Reading & Writing – 50 CO3 & CO4

CO	Internal Exam % of Marks	Terminal Exam % of Marks
CO1	**20**	**20**
CO2	**40**	**30**
CO3	**20**	**25**
CO4	**20**	**25**
Total	**100**	**100**

Syllabus

Module 1: Listening Skills CO1

Importance of LSRW skills in Technical and Non-technical context - Listening for gist and specific information – Listening to interviews, TED talks and workplace conversations – Note-taking technique– Introduction to differences in native and non-native accents and pronunciation

Module 2: Speaking Skills and Collaborative Communication CO2

Active listening and feedback strategies - Self-introduction – JAM sessions on SDG 4, 5 & 11–Professional conversations – Meetings and negotiations – Data Interpretation and Presentation Articulation - Brain storming on various SDGs

Module 3: Reading Skills CO3

Reading technical articles, reports– Skimming and scanning – Critical reading – Vocabulary and Extensive Reading– Contextual vocabulary – Academic and professional vocabulary building- prefixes and suffixes.

Module 4: Writing Skills Grammar and Professional Documentation CO4

Sentence structures – Tenses and error correction – Phrasal Verbs - Cohesion and coherence – Email writing – Formal Letter Writing – Technical report writing – Creating identity in Digital platforms.

Reference Books & web resources

1. Carnegie, Dale. *The Quick and Easy Way to Effective Speaking*. Pocket Books, 2003.
2. Raman, Meenakshi, and Sangeeta Sharma. *Technical Communication: Principles and Practice*. 3rd ed., Oxford University Press, 2015.
3. Swan, Michael. *Practical English Usage*. 4th ed., Oxford University Press, 2016.
4. Wren, P. C., and H. Martin. *High School English Grammar and Composition*. Revised ed., S. Chand Publishing, 2018.
5. https://learnenglish.britishcouncil.org
6. https://www.ted.com/talks
7. https://owl.purdue.edu
8. https://www.cambridgeenglish.org/learning-english/

9. https://www.oxfordonlineenglish.com

Extensive Reading Books

1. *Jonathan Livingston Seagull* -- Novella by Richard Bach
2. *Ikigai: The Japanese Secret to a Long and Happy Life* by Héctor García and Francesc Miralles

SDG Alignment

Activities aligned with SDGs addressed:

1. Listening - SDG (4)
2. Speaking - SDG (4)
3. Brainstorming on various SDGs
4. JAM sessions on SDG 4,5 & 11

Course Contents and Lecture Schedule

S. No.	Topics	No of Periods
1.1	Importance of LSRW skills in Technical and Non-technical context	1
1.2	Listening for gist and specific information	1
1.3	Listening to interviews, TED talks and workplace conversations	3
1.4	Note-taking technique	1
1.5	Introduction to differences in native and non-native accents and pronunciation	1
2.1	Active listening and feedback strategies	1
2.2	Self-introduction	1
2.3	JAM sessions on SDG 4, 5 & 11	2
2.4	Professional conversations	1
2.5	Data Interpretation and Presentation Articulation	2
2.6	Brain storming on various SDGs	1
2.7	Meetings and negotiations - Activity	1
3.1	Reading technical articles, Skimming and scanning Critical reading	3
3.2	Vocabulary and Contextual vocabulary	3
3.3	Academic and professional vocabulary	3
3.4	Vocabulary building- prefixes and suffixes.	2
4.1	Sentence structures	1
4.2	Tenses and error correction	1
4.3	Phrasal Verbs	1
4.4	Cohesion and coherence	1
4.5	Email writing	1
4.6	Formal Letter Writing	1
4.7	Technical report writing	2
4.8	Creating identity in Digital platforms	1
	Total Hours	**36**

Course Designers:

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		Category	L	T	P	Credit
26DSKF0	**THEORY OF PROBABILITY**	FC	3	1	0	4

Preamble

This course helps students understand how to use conditional probability and Bayes' theorem to solve real-life problems. It also teaches how to use moment generating functions for both discrete and continuous probability distributions to find probability values. In addition, students will learn about limit theorems, especially the central limit theorem, and understand how they are applied in practical situations.

Prerequisite

- NIL

Course Outcomes

On the successful completion of the course, students will be able to

No.	Course Outcome	TPS Level	Performance Indicator	CO Weightage	SDG addressed	SDG Level	PSOs
CO1	Apply Bayes' theorem to solve uncertainty-based real-world problems.	3	1.1.1	10	9	2	1
CO2	Use probability mass functions and density functions to determine expectation and variance of discrete and continuous random variables.	3	1.1.1	20	9	2	1
CO3	Implement suitable probability distributions for modelling data science applications.	3	1.1.1	20	9	2	1, 2
CO4	Solve problems involving joint, marginal, and conditional distributions and also transformation of variables in discrete and continuous random variables.	3	1.1.1	20	11	2	1
CO5	Use the application of central limit theorem in statistical analysis and data interpretation.	3	1.1.1	15	9	2	1, 2
CO6	Evaluate system reliability and expected lifetime of independent component systems using probability concepts.	3	1.1.1	15	11	2	1, 2

Assessment Pattern

CO	CAT1	Assignment 1	CAT2	Assignment 2	Terminal Exam
	% of Marks	% of Marks	% of Marks	% of Marks	% of Marks
CO1	**20**	**20**	**-**	**-**	**10**
CO2	**40**	**40**	**-**	**-**	**20**
CO3	**40**	**40**	**-**	**-**	**20**
CO4	**-**	**-**	**40**	**40**	**20**
CO5	**-**	**-**	**30**	**30**	**15**
CO6	**-**	**-**	**30**	**30**	**15**
Total	**100**	**100**	**100**	**100**	**100**

Syllabus

Probability Basic Concepts: Introduction - Sample space and events – Basic Theorems - Conditional Probability – Baye's Theorem - Independence.

Random Variables: Discrete and continuous random variables - probability mass function and density function - Distribution function - Expectation and variance – Moments and Moment Generating functions - Sums of independent random variables.

Theoretical Distributions: Discrete: Binomial, Bernoulli, Poisson and Geometric.
Continuous: Uniform, Normal, Exponential, Weibull, and Gamma.

Two Dimensional Random Variable: Joint probability distributions - Marginal and conditional distributions - Statistical independence - Conditional expectation – Transformation of two random variables.

Central Limit Theorems: Limit theorems: Markov and Chebyshev inequalities, Law of Large numbers, Central Limit Theorem.

Reliability: Introduction - Structure Functions - Reliability of Systems of Independent Components - System Life as a Function of Component Lives - Expected System Lifetime.

Text Book

1. Sheldon M. Ross, "Introduction to Probability Models", Academic Press, 12th edition 2019.
2. K. S. Trivedi, "Probability and Statistics with Queuing, Reliability and Computer Science Applications", John Wiley &Sons, 2016.

Reference Books & web resources

1. Jay L Devore, "Probability and Statistics for Engineering and Sciences", Cengage Learning, 2015.
2. Saeed Ghahramani, "Fundamentals of Probability with Stochastic Processes", Pearson Education, 4th edition 2019.
3. https://www.khanacademy.org/math/statistics-probability
4. https://www.probabilitycourse.com/
5. https://mathworld.wolfram.com/topics/ProbabilityandStatistics.html
6. NPTEL course on Probability and Statistics, IIT Kharagpur https://onlinecourses.nptel.ac.in/e-learning/preview/noc21_ma74

SDG Alignment

Activities aligned with SDGs addressed:

1. Bayes' theorem, probability models, probability distributions, and the central limit theorem support data analysis, predictive modelling, machine learning, and statistical inference, contributing to technological innovation and industrial applications.(SDG 9 – Industry, Innovation and Infrastructure).

2. Statistical analysis of multiple variables and reliability theory support efficient planning, resource management, and the development of safe and sustainable community infrastructure. (SDG 11 – Sustainable Cities and Communities).

Course Contents and Lecture Schedule

Module No.	Topic	No. of Periods
1	**Probability Basic Concepts**	

Module No.	Topic	No. of Periods
1.1	Introduction and Sample space and events, Basic theorems	2
1.2	Conditional Probability	1
1.3	Baye's Theorem	2
1.4	Independence	2
2	**Random Variables**	
2.1	Discrete and Continuous random variables	2
2.2	Probability mass function and density function	2
2.3	Distribution function	1
2.4	Expectation and variance	2
2.5	Moments and moment generating functions	2
2.6	Sums of independent random variables	2
3	**Theoretical Distributions**	
3.1	Discrete: Binomial, Bernoulli	2
3.2	Poisson, Geometric.	2
3.3	Continuous: Uniform, Normal	2
3.4	Exponential, Weibull, and Gamma.	2
4	**Two Dimensional Random Variables**	
4.1	Joint probability distributions	2
4.2	Marginal and conditional distributions	2
4.3	Statistical independence, Conditional expectation	2
4.4	Transformation of two random variables.	2
5	**Central Limit Theorems**	
5.1	Limit theorems: Markov and Chebyshev inequalities	2
5.2	Law of Large numbers	2
5.3	Central Limit Theorem.	2
6	**Reliability**	
6.1	Introduction - Structure Functions	2
6.2	Reliability of Systems of Independent Components	2
6.3	System Life as a Function of Component Lives	2
6.4	Expected System Lifetime	2
	Total	48

Course Designer(s):

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		Category	L	T	P	Credits
26DSKG0	**GRAPH THEORY**	FC	3	1	0	4

Preamble

This course introduces the fundamental concepts of Graph Theory and their applications in solving real-world and computational problems. It covers graphs, digraphs, trees, connectivity, planarity, colouring, domination, and shortest path problems, with emphasis on network modelling and applications in computer science and related fields.

Prerequisite

- Nil

Course Outcomes

On the successful completion of the course, students will be able to

No.	Course Outcome	TPS Level	Performance Indicator	CO Weightage	SDG addressed	SDG Level	PSOs
CO1	Apply the basic concepts of Graphs, walk, path, circuits and also the concepts of Eulerian, Hamiltonian graphs in real life problems.	3	1.1.1	15	9	1	1
CO2	Implement the concepts of trees and connectivity for network problems.	3	1.2.1	20	9	1	1
CO3	Implement digraph concepts in solving Data Science problems.	3	1.1.1	15	11	1	2
CO4	Apply the planarity and duality concepts for solving Data Science related problems.	3	1.1.1	15	9	1	2
CO5	Use the matrix representation of graphs and solve minimum path finding problem.	3	1.2.1	20	11	1	2
CO6	Apply the concepts of Colouring and Covering for solving real time problems.	3	1.2.1	15	9	1	2

Assessment Pattern

CO	CAT1	Assignment 1	CAT2	Assignment 1	Terminal Exam
	% of Marks	% of Marks	% of Marks	% of Marks	% of Marks
CO1	30	30	-		20
CO2	40	35	-		10
CO3	30	35	-		20
CO4	-		30	30	15
CO5	-		40	35	20
CO6	-		30	35	15
Total	**100**	**100**	**100**	**100**	**100**

Syllabus

Module 1: Introduction:
Graphs and its Applications, Finite and Infinite Graphs, Incidence and Degree, Isolated Vertex, Pendant Vertex and Null Graph. Isomorphism, Sub graphs, Walks, Paths and Circuits, Connected and Disconnected Graphs and Components, Euler Graphs, Hamiltonian Paths and Circuits, Travelling Salesman Problem.

Module 2: Trees and Fundamental Circuits:
Trees and its Properties, Distance and Centres, Rooted and Binary Trees, Spanning Trees.

Module 3: Directed Graphs:
Digraphs and Binary Relations Directed Paths and Connectedness, Euler Digraphs, Trees with Directed Edges, Acyclic Digraphs.

Module 4: Planar Graphs:
Planar Graphs, Kuratowski's Two Graphs, Euler's formula - Combinatorial and Geometric Graphs and its Dual.

Module 5: Matrix Representation Of Graphs:
Incidence Matrix, Adjacency Matrix, Path Matrix, Shortest Path using Dijkstra's, Prim's & Kruskal's algorithm.

Module 6: Colouring And Covering:
Vertex Colouring, Edge Colouring, Chromatic Number, Chromatic Polynomial, Coverings, Four Colour Problem and Five-colour theorem.

Text Book

1. Douglas B. West, "Graph Theory", Pearson Education, 2015.
2. Bondy J.A. and Murty U.S.R, "Graph Theory", Springer, 2013.

Reference Books & web resources

1. Narsingh Deo, "Graph Theory with Applications to Engineering and Computer Science", 2016.
2. NPTEL – Graph Theory - IIT Madras https://nptel.ac.in/courses/111106050
3. NPTEL – Graph Theory – IISER Pune - https://onlinecourses.nptel.ac.in/e-learning/preview/noc25_ma26
4. MIT OpenCourseWare – 6.042J | Fall 2010 | Undergraduate, https://ocw.mit.edu/courses/6-042j-mathematics-for-computer-science-fall-2010/video_galleries/video-lectures/
5. MIT OpenCourseWare – 18.225 | Fall 2023 | Graduate https://ocw.mit.edu/courses/18-225-graph-theory-and-additive-combinatorics-fall-2023/

SDG Alignment

Activities aligned with SDGs addressed:

1. Applying graph theory concepts such as paths, circuits, trees, connectivity, and shortest path algorithms to solve real-world network and optimization problems. (SDG 11 – Sustainable Cities and Communities)
2. Using graph colouring, digraphs, and matrix representations for computational modeling, scheduling, and infrastructure-related applications, thereby promoting innovation and technological problem-solving. (SDG 9 – Industry, Innovation and Infrastructure)

Course Contents and Lecture Schedule

Module No.	Topic	No. of Periods
1	**Introduction: Basic Concepts of Graphs**	
1.1	Basic Definitions of graphs with examples	2
1.2	Paths and Circuits concepts with example	2
1.3	Classify the Eulerian and Hamiltonian graphs	3
1.4	Travelling Salesman Problem.	2
2	**Trees and Fundamental Circuits**	
2.1	Trees and its Properties	2
2.2	Concepts of Rooted, Binary Trees and Spanning Trees	3
2.3	Theorems and Properties of Trees	2
3	**Directed Graphs**	
3.1	Digraphs and Binary Relations, ,	1
3.2	Directed Paths and Connectedness	2
3.3	Euler Digraphs	1
3.4	Trees with Directed Edges	2
3.5	Acyclic Digraphs	2
4	**Planar Graphs**	
4.1	Planar Graphs Properties	3
4.2	Kuratowski's Two Graphs, Euler's formula	2
4.3	Combinatorial and Geometric Graphs and its Dual	2
5	**Matrix Representation Of Graphs**	
5.1	Incidence Matrix, Adjacency Matrix Problems	3
5.2	Path Matrix Problems	2
5.3	Shortest Path using Dijkstra's, Prim's & Kruskal's algorithm.	3
6	**Colouring and Covering**	
6.1	Vertex Colouring, Edge Colouring	3
6.2	Chromatic Number, Chromatic Polynomial	2
6.3	Coverings	2
6.4	Four Colour Problem and Five-colour theorem.	2
	Total Periods	**48**

Course Designer(s):

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26DSCA0	DATA STRUCTURES	Category	L	T	P	Credit
		*PCC	4	0	0	4

Preamble

This course aims at providing a deep understanding of various data structures, their operations and analysis, and enables students to identify appropriate data structures, apply relevant searching and sorting techniques, and design suitable algorithms for real-world software requirements.

Prerequisite

26DSKD0- Problem Solving using C Programming

Course Outcomes

On the successful completion of the course, students will be able to

No.	Course Outcome	TPS Level	Performance Indicator	CO Weightage	SDG addressed	SDG Level	PSOs
CO1	Explain the organization and operations of fundamental data structures.	2	1.4.1	10	9	2	1
CO2	Demonstrate the operations of arrays and linked lists along with searching and sorting techniques on linear data.	3	1.4.1, 2.4.1	20	9	2	1
CO3	Demonstrate the operations of stacks and their applications such as recursion and expression processing.	3	1.4.1, 2.4.1	15	9	2	1
CO4	Demonstrate the operations of queues, dequeues and their applications using sequential and linked implementations.	3	1.4.1, 2.4.1	15	9	2	1
CO5	Implement non-linear data structures such as binary trees and binary search trees.	3	1.4.1, 3.3.1	20	9	3	1, 2
CO6	Compare hash-table collision-handling techniques (chaining, linear and quadratic probing, double hashing) for varying load factors.	4	2.2.2, 2.1.3	20	9	3	1, 2

Assessment Pattern

CO	CAT1	Assignment1	CAT2	Assignment2	Terminal Exam
	% of Marks	% of Marks	% of Marks	% of Marks	% of Marks
CO1	20		-	-	10
CO2	40	50	-	-	20
CO3	40	50	-	-	15
CO4	-	-	30	30	15
CO5	-	-	30	30	20
CO6	-	-	40	40	20
Total	**100**	**100**	**100**	**100**	**100**

Syllabus

Module 1 – Introduction: Abstraction – Data structures – Abstract Data Types – Primitive data structures – Types of data structures.

Module 2 – Arrays, Linked Lists, Searching and Sorting: Data storage and primitive operations with arrays – Linear search – Binary search – Bubble sort – Selection sort – Insertion sort – Quick sort – Merge sort – Singly linked lists – Doubly linked lists – Circular linked lists – Applications: Addition of polynomials, Sparse matrix representation.

Module 3 – Stacks: Primitive operations – Sequential implementation – Linked stacks – Applications: Recursion, Expression processing.

Module 4 – Queues: Primitive operations – Sequential implementation – Dequeues – Applications – Linked queues – Dynamic storage management.

Module 5 – Trees: Terminologies – Implementation – Binary tree: properties – Sequential and linked representation – Traversals – Expression trees – Infix, Postfix and Prefix expressions – Binary Search Tree: insertion, deletion and other operations – Need for balancing.

Module 6 – Hash Tables: Hash function – Separate chaining – Open addressing – Linear probing – Quadratic probing – Double hashing – Rehashing.

Text Book

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, “Introduction to Algorithms”, Fourth Edition, MIT Press, 2022. (Chapters 1, 2, 3, 7, 10, 11, 12, 13)

Reference Books & web resources

1. Mark Allen Weiss, Data Structures and Algorithm Analysis in C, 2nd Edition, Pearson Education, 1996. (Chapter 4)
2. Reema Thareja, Data Structures Using C, 3rd Edition, Oxford University Press, 2023.
3. Yashavant Kanetkar, “Data Structures Through C”, Fourth Edition, BPB Publications, 2022.
4. MIT OpenCourseWare – 6.006 Introduction to Algorithms: https://ocw.mit.edu/courses/6-006-introduction-to-algorithms-spring-2020/
5. NPTEL – Programming, Data Structures and Algorithms using C: https://nptel.ac.in/courses/106/102/106102064/

SDG Alignment

Activities aligned with SDGs addressed:

1. Algorithm-analysis assignment *(SDG 9 – Level 2)* — Modules 1 and 2 Students measure and tabulate the best, worst and average case running times of linear search, binary search and the sorting algorithms covered in the syllabus on varying input sizes, and report which algorithm scales best for industrial-scale data.

2. Implementation exercise *(SDG 9 – Level 2)* — Modules 2 and 3 Students implement linked-list applications (addition of polynomials and sparse-matrix representation) and stack-based expression evaluation (infix-to-postfix conversion and evaluation) for use in a calculator or compiler front-end module.

3. Queue-based simulation *(SDG 9 – Level 2)* — Module 4 Students develop a queue or dequeue-based simulation of a real-world service system (Job-request handling) using both sequential and linked implementations and compare their dynamic storage utilization.

4. Case study on tree-based indexing *(SDG 9 – Level 3)* — Module 5 Students study, implement and present a Binary Search Tree and AVL tree-based dictionary or directory structure used in resilient infrastructure software (file-system indexing) and report the impact of balancing on search/insert/delete performance.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Periods
1	**INTRODUCTION**	
1.1	Abstraction – Data structures – Abstract Data Types	2
1.2	Primitive data structures – Types of data structures	2
2	**ARRAYS, LINKED LISTS, SEARCHING AND SORTING**	
2.1	Data storage and primitive operations with arrays	2
2.2	Linear search and Binary search – analysis	2
2.3	Bubble sort, Selection sort	2
2.4	Insertion sort	1
2.5	Quick sort	1
2.6	Merge sort	1
2.7	Singly linked lists	2
2.8	Doubly linked lists	1
2.9	Circular linked lists	1
2.10	Application: Addition of polynomials	1
2.11	Application: Sparse matrix representation	1
3	**STACKS**	
3.1	Primitive operations – Sequential implementation	2
3.2	Linked stacks	1
3.3	Application: Recursion	1
3.4	Application: Expression processing (infix, postfix, prefix conversions and evaluation)	2

4	**QUEUES**	
4.1	Primitive operations – Sequential implementation	2
4.2	Dequeues – Applications	2
4.3	Linked queues	1
4.4	Dynamic storage management	2
5	**TREES**	
5.1	Terminologies – Implementation – Binary tree: Properties	1
5.2	Sequential and linked representation	1
5.3	Traversals – Expression trees – Infix, Postfix and Prefix expressions	2
5.4	Binary Search Tree – Search and Insertion	2
5.5	Binary Search Tree – Deletion and other operations	2
5.6	Applications of BST	2
6	**HASH TABLES**	
6.1	Hash function – Separate chaining	2
6.2	Open addressing – Linear probing, Quadratic probing	2
6.3	Double hashing – Rehashing	2
	Total Periods	**48**

Course Designer:

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26DSCB0	OBJECT ORIENTED PROGRAMMING	Category	L	T	P	Credit
		PCC	4	0	0	4

Preamble

This course introduces the fundamentals of Object-Oriented Programming using C++, enabling students to transition from procedural to object-based problem solving. It focuses on core concepts such as classes, encapsulation, inheritance, and polymorphism. The course emphasizes design-oriented thinking and modular programming. The course connects OOP principles to modern software development practices in data science applications.

Prerequisite

- 26DSKD0- Problem Solving Using C Programming

Course Outcomes

On the successful completion of the course, students will be able to

No.	Course Outcome	TPS Level	PI	CO Weightage	SDG	SDG Level	PSOs
CO1	Apply class and object concepts to design solutions with proper encapsulation and data abstraction.	3	1.4.1	15	-	-	1
CO2	Implement constructors and destructors to manage object lifecycle effectively in program design.	3	2.4.1 1.4.1	10	-	-	1
CO3	Apply function overloading and operator overloading to achieve compile-time polymorphism.	3	1.4.1	15	-	-	1
CO4	Design class hierarchies using inheritance for code reusability and extensibility demonstrating dynamic binding concepts	3	2.1.1 3.4.1	25	4	2	2
CO5	Apply input/output stream handling concepts including Console I/O and file streams for solving user defined problems	3	1.4.1 5.3.1	15	4	2	2
CO6	Develop reusable and robust object-oriented programs using templates, exception handling and STL containers, algorithms and iterators	3	1.3.1 5.3.1	20	4	2	2

Assessment Pattern

CO	CAT1	Assignment1	CAT2	Assignment2	Terminal Exam
	% of Marks	% of Marks	% of Marks	% of Marks	% of Marks
CO1	30	40	-	-	15
CO2	20	20	-	-	10
CO3	30	40	-	-	15
CO4	20	-	30	40	25
CO5	-	-	30	30	15
CO6	-	-	40	30	20
Total	**100**	**100**	**100**	**100**	**100**

Syllabus

Principles of Object Oriented Programming: Procedure Oriented Programming - Object Oriented Programming Paradigm - Basic Concepts and Benefits of OOP - Object Oriented Programming Language - Application of OOP in modern settings – Case study.

C++ constructs: Newer data types**,** Tokens, Expressions and Control Structures - Operators in C++ - Functions - Call by Reference - Return by reference - Inline functions - Default, Const Arguments- String operations

Classes and Objects: Member functions - Nesting of Member functions - Private member functions - Memory allocation for Objects - Static data members - Static Member Functions - Arrays of Objects - Objects as Function Arguments - Returning Objects - Const Member functions – Pointers to members – this pointer – const objects – Friend functions – Nested classes - Friend classes

Constructors & Destructors: Constructors – Types of constructors - Multiple Constructors in a Class - Constructors with Default Arguments - Dynamic Initialization of Objects - Copy and Dynamic Constructors – Destructor overloading.

Operator overloading and Function overloading : Operator Overloading**:** Overloading Binary Operators - Overloading Binary Operators using Friend functions – Unary operator - Operator Type conversion – Function overloading

Inheritance: Defining Derived Classes - Single Inheritance –- Multiple Inheritance - Access rights - Hierarchical Inheritance - Hybrid Inheritance - Virtual Base Classes - Abstract Classes - Constructors in Derived Classes - Member Classes - Nesting of Classes – Composition – Aggregation .

Polymorphism: Basics of polymorphism – Types of polymorphism - Compile and Run Time Polymorphism - Virtual function – Object slicing– Virtual Destructor – Dynamic binding.

Streams: Stream classes – Unformatted and formatted I/O operations- I/O manipulators – File streams – File operations – Sequential and Random access operations – Error handling

Templates & Exception Handling: Introduction to Templates – Class templates – Function templates – Overloading of function templates - Basic Exception Handling – Throwing , catching and rethrowing – Creating custom exceptions – Using System defined exceptions

Standard Template Library(STL): STL Components – Container (List, Queue, Stack, Vector) – Algorithms – Iterators

Text Book

1. Bjarne Stroustrup, “The C++ Programming Language”, Pearson Education,4th edition, 2013.

2. Yashavant P. Kanetkar, “Let Us C++”, BPB Publications, 2019

Reference Books & web resources

1. E. Balagurusamy, "Object Oriented Programming with C++", Tata McGraw-Hill, 8th Edition, 2020.
2. Stanley B. Lippman, Josée Lajoie & Barbara E. Moo, "C++ Primer", Addison-Wesley, 5th Edition, 2012
3. C++ tutorial: https://www.learncpp.com
4. C++ Practice exercises: https://www.geeksforgeeks.org/cpp/c-plus-plus/

SDG Alignment

Activities aligned with SDG: Micro projects for quality education monitoring

Course Contents and Lecture Schedule

Module No.	Topics	No. of Periods
1	**Principles of Object Oriented Programming (3)**	
1.1	Procedure Oriented Programming & Object Oriented Programming Paradigm, Basic concepts and Benefits of OOP	1
1.2	Object Oriented Programming Language	1
1.3	Applications of OOP in Modern Settings – Case Study	1
2	**C++ Constructs (5)**	
2.1	Newer Data Types, Tokens and expressions	1
2.2	Control Structures and Operators in C++	1
2.3	Functions – Call by Reference & Return by Reference	1
2.4	Inline Functions – Default and Const Arguments	1
2.5	String Operations	1
3	**Classes and Objects (8)**	
3.1	Class declaration, Member Functions and use of objects	1
3.2	Nesting of Member Functions & Private Member Functions	1
3.3	Memory Allocation for Objects, Static member and Static functions	1
3.4	Arrays of Objects	1
3.5	Objects as Function Arguments & Returning Objects	1
3.6	Const Member Functions – Const Objects, Pointers to Members & this Pointer	1
3.7	Friend Functions	1
3.9	Nested Classes & Friend Classes	1
4	**Constructors and Destructors (4)**	
4.1	Constructors and Types of Constructors, Multiple Constructors in a Class	1
4.2	Multiple Constructors in a Class	1
4.3	Constructors with Default Arguments, Dynamic Initialization of Objects	1
4.4	Copy and Dynamic Constructors – Destructor Overloading	1
5	**Operator Overloading and Function Overloading (4)**	
5.1	Operator Overloading – Introduction, Overloading binary operators	1
5.2	Overloading Binary Operators using Friend Functions	1
5.3	Unary Operator Overloading & Operator Type Conversion	1
5.4	Function Overloading	1

6	**Inheritance (6)**	
6.1	Defining Derived Classes & Single Inheritance	1
6.2	Multiple Inheritance, Access rights	1
6.3	Hierarchical and Hybrid Inheritance	1
6.4	Virtual Base Classes & Abstract Classes	1
6.5	Constructors in Derived Classes	1
6.6	Member Classes – Nesting of Classes – Composition – Aggregation	1
7	**Polymorphism (3)**	
7.1	Basics and Types of Polymorphism, Compile Time and Run Time Polymorphism	1
7.2	Virtual Functions & Dynamic Binding	1
7.3	Object Slicing & Virtual Destructor	1
8	**Streams (6)**	
8.1	Stream Classes – Unformatted and Formatted I/O Operations	1
8.2	I/O Manipulators	1
8.3	File Streams – File operations – File opening modes	1
8.4	Sequential File operations	2
8.5	Random Access Operations – Error Handling in File Operations	1
9	**Templates and Exception Handling (6)**	
9.1	Class Templates	2
9.2	Function Templates – Overloading of Function Templates	1
9.3	Basic Exception Handling – Throwing, Catching and Rethrowing	1
9.4	Creating customized exceptions	1
9.5	Using System defined exceptions	1
10	**Standard Template Library (STL) (3)**	
10.1	STL Components – Containers (List, Queue, Stack, Vector)	2
10.2	Algorithms and Iterators	1
	Total	**48**

Course Designer(s):

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26DSCC0	ORGANIZATIONAL THEORY AND BEHAVIOR	Category	L	T	P	Credit
		PCC	3	0	0	3

Preamble

To develop an understanding of organizational structures, theories, and human behaviour in workplace settings from a behavioural science perspective. This course enables learners to analyse individual and group dynamics, organizational culture, leadership, and decision-making processes to enhance organizational effectiveness and foster positive workplace relationships.

Prerequisite

Nil.

Course Outcomes

On the successful completion of the course, students will be able to

No.	Course Outcome	TPS Level	Performance Indicator	CO Weightage	SDG addressed	SDG Level	PSOs
CO1	Develop an Organisational Behaviour model for any type of Organization.	3	8.1.1	10	4, 8	3	PSO1
CO2	Develop Managerial skills for Individual Behaviours.	3	9.1.1	12	8	3	PSO1
CO3	Build leadership qualities for effective team and organizational performance.	3	8.2.1	18	4, 8	3	PSO1, PSO2
CO4	Analyze the Common biases and eradication in Decision Making Process.	3	8.3.1	18	8	3	PSO1, PSO2
CO5	Adapt to the different organizational cultures and work environments.	4	6.3.1	22	8, 9	3	PSO1, PSO2
CO6	Analyze and Learn techniques to manage workplace stress and maintain job performance	4	2.4.2	20	3, 8	3	PSO1, PSO2

Assessment Pattern

CO	CAT 1 % of Marks	Assignment 1 % of Marks	CAT 2 % of Marks	Assignment 2 % of Marks	Terminal Exam % of Marks
CO1	20	20	-	-	10
CO2	40	40	-	-	10
CO3	40	40	-	-	20
CO4	-	-	20	20	20
CO5	-	-	40	40	20
CO6	-	-	40	40	20
Total	**100**	**100**	**100**	**100**	**100**

Syllabus

Module 1

Organizational Behavior: Introduction to Organizational Behavior(OB), Contributing disciplines to OB Field, challenges and opportunities for OB, Developing an OB Model, Foundation of Individual Behavior, Ability - Learning. Values, Attitudes and Types of Attitudes.

Module 2

Job satisfaction- Measuring Job satisfaction, Effect of Job satisfaction on employee performance.

Module 3

Personality and Values: Personality determinants, achieving personality fit, Factors Influencing perception, Attribution Theory, Perception / Individual Decision Making: Ethics in Decision Making. Motivation, Management by Objectives, Employee Recognition programs, Employee Involvement programs, Variable Pay Programs.

Module 4

Understanding work teams: Teams Vs Groups – Types of Teams, Creating Effective Teams – Turning Individuals into Team Players.

Module 5

Communication: Functions of Communication, Communication Process – Direction of communication, Interpersonal and Organizational communication, Barriers of effective communication, Current issues in Communication.

Module 6

Leadership: Leadership – Meaning, Trait Theories – Behavioural Theories, Contingency Theories, Contemporary issues in Leadership.

Module 7

Organizational culture and Stress Management: Meaning – Creating and sustaining culture, How employees learn culture, creating an ethical organizational culture, creating a customer responsive culture, spirituality and organizational culture, Work stress and its Management.

Text Books

1. Stephen P. Robbins, “Organisational Behaviour”, 11th edition., Pearson, 2022.
2. Uma Sekaran, “Organisational Behaviour”, 2nd ed., Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2019.
3. R. A. Sharma, “Organisational Theory and Behaviour”, 2nd edition., Tata McGraw-Hill Ltd., New Delhi, 2012.

Reference Books & web resources

1. Fred Luthans, “Organizational Behaviour: An Evidence-Based Approach”, 14th edition., McGraw-Hill Education, 2023.

2. John R. Schermerhorn, James G. Hunt, Richard N. Osborn, and Mary Uhl-Bien, “Organizational Behaviour”, 13th edition., Wiley, 2019.
3. Jerald Greenberg and Robert A. Baron, “Behaviour in Organizations”, 10th edition., Pearson Education, 2018.
4. Aswathappa K., “Organisational Behaviour”, 13th edition., Himalaya Publishing House, 2021.SAGE Publications – Organizational Studies and Behaviour Journals
5. OpenStax – “Organizational Behavior: https://openstax.org/books/organizational-behavior
6. RapidBI – “Organizational Theory and Behavior” : https://rapidbi.com/organizational-theory-and-behavior-walonick/

SDG Alignment

SDGs Addressed: SDG 3 (Good Health and Well-being), SDG 4 (Quality Education), SDG 8 (Decent Work and Economic Growth), SDG 9 (Industry, Innovation and Infrastructure)

Activities aligned with SDGs addressed:

1. SDG 8 – Case study on employee motivation and recognition programs in a technology company: students analyse how variable pay and involvement programs affect productivity and worker well-being, linking OB theory to decent-work outcomes. (Module 2, TPS 2–3)
2. SDG 8 & SDG 9 – Group exercise on team design and communication: students compare functional vs cross-functional team structures for a data-driven startup, evaluating which design best supports innovation and inclusive workplaces. (Module 3, TPS 3–4)
3. SDG 3 & SDG 8 – Analysis exercise on workplace stress factors and management strategies: students examine stress sources in an organizational scenario, propose evidence-based interventions, and evaluate their impact on employee health and workplace productivity. (Module 5, TPS 4)
4. SDG 4 – Reflection activity on ethical organizational culture: students examine real cases of unethical conduct in organizations and propose ethically justified responses aligned with professional codes, reinforcing quality education outcomes in applied ethics. (Module 5)

Course Contents and Lecture Schedule

Module .No	Topics	No. of Lectures
1	**Organizational Behavior**	
1.1	Introduction to Organizational Behavior (OB)	1
1.2	Contributing disciplines to OB Field	1
1.3	Challenges and opportunities for OB	1
1.4	Developing an OB Model	1
1.5	Foundation of Individual Behavior	2
1.6	Ability - Learning. Values, Attitudes and Types of Attitudes	2
2	**Job satisfaction**	
2.1	Measuring Job satisfaction.	2
2.2	Effect of Job satisfaction on employee performance.	2
3	**Personality and Values**	
3.1	Personality – Personality determinants	2
3.2	Achieving personality fit, Factors Influencing perception	2

3.3	Attribution Theory, Ethics in Decision Making. Motivation	2
3.4	Management by Objectives	1
3.5	Employee Recognition programs & Involvement programs	1
4	**Understanding work teams**	
3.1	Teams Vs Groups – Types of Teams	1
3.2	Creating Effective Teams – Turning Individuals into Team Players	2
5	**Communication**	
5.1	Functions of Communication	1
5.2	Communication Process – Direction of communication	2
5.3	Interpersonal and Organizational communication	1
5.4	Barriers of effective communication	1
5.5	Current issues in Communication	1
6	**Leadership**	1
6.1	Leadership – Meaning	1
6.2	Trait Theories – Behavioral Theories	2
6.3	Contingency Theories	1
6.4	Contemporary issues in Leadership	1
6.5	The foundation of leadership	1
7	**Organizational culture and Stress Management**	
7.1	Organizational culture: Meaning – Creating and sustaining culture	2
7.2	How employees learn culture, creating an ethical organizational culture	2
7.3	creating a customer responsive culture, spirituality and organizational culture	2
	Organizational change and Stress Management	
7.4	Approaches to Managing organizational change	2
7.5	Creating a Culture, Change in Business	2
7.6	Work stress and its Management	2
	Total	**48**

Course Designer:

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26DSEB0 DATA STRUCTURES LAB

Category	L	T	P	Credit
PCC*	0	0	6	2

Preamble

This laboratory course provides hands-on experience in implementing and analysing classical data structures and the algorithms that operate on them. Programs are written in C++; the in-built C++ Standard Template Library is used to compare custom implementations against industry-standard library implementations.

Prerequisite

- 26DSEA0 – C Programming Lab

Course Outcomes

On the successful completion of the course, students will be able to

No.	Course Outcome	TPS Level	Performance Indicator	Objective	SDG Addressed	SDG Level	PSOs
CO1	Design algorithms for the given problem specifications by choosing appropriate data structures and relevant operations.	3	1.4.1, 3.4.1	Design	9	2	1
CO2	Implement searching and sorting techniques on arrays in an application context.	3	2.4.1	Experimentation	9	2	1
CO3	Implement linear data structures (linked lists, stacks, queues) in an application context.	3	2.4.1	Experimentation	9	2	1
CO4	Implement non-linear data structures (trees) in an application context.	4	2.4.1	Experimentation	9	3	1, 2
CO5	Implement hash tables and apply them to solve a given problem.	3	2.4.1	Experimentation	9	2	1, 2
CO6	Prepare laboratory reports for the applications developed, with neat program listings, sample inputs and outputs.	3	9.1.2	Communication	4	2	1

Assessment Pattern

Type of Assessment	Component	Marks	Remarks
Continuous Assessment	Pre-lab, In-lab, Post-lab	75	Conducted throughout the semester
Model Test	CO-wise (Cognitive, Psychomotor, Affective)	25	Mid / End semester internal test
Total Internal Marks		**100**	
End Semester Examination	CO-wise (Cognitive, Psychomotor, Affective)	100	As directed by COE or as per curriculum

List of Experiments with CO Mapping

Sl. No.	Name of the Experiment	Level of Experiment	COs Addressed
1	Searching algorithms on arrays – Linear Search – Binary Search – Comparison of number of comparisons across best, average and worst cases.	1	CO1, CO2
2	Sorting algorithms on arrays (elementary) – Bubble Sort – Selection Sort – Insertion Sort – Tabulation of running time for ordered, reverse-ordered and random inputs.	1	CO1, CO2
3	Sorting algorithms on arrays (divide and conquer) – Quick Sort – Merge Sort – Performance comparison against elementary sorts for large inputs.	2	CO1, CO2
4	Linked lists – Singly Linked List – Doubly Linked List – Circular Linked List – Insertion, deletion, search and traversal operations.	1	CO1, CO3
5	Application of linked lists – Addition of two polynomials – Sparse matrix representation.	2	CO1, CO3, CO6
6	Stack and its applications – Stack using arrays – Stack using linked list – Infix to postfix conversion – Postfix expression evaluation.	1	CO1, CO3, CO6
7	Queues – Queue using arrays – Circular Queue – Linked Queue – Enqueue and dequeue operations with overflow / underflow handling.	1	CO1, CO3, CO6
8	Binary tree and binary search tree – Binary tree traversals (in-order, pre-order, post-order, level-order) – BST insertion, search and deletion – Height of the tree, count of nodes (total / leaf / internal) – Lowest common ancestor of two given nodes – Listing ancestors of a given node – Check whether a given binary tree is a BST.	1	CO1, CO4, CO6
9	Hash table – Separate chaining – Open addressing with linear probing – Comparison of average number of probes per search for different load factors.	2	CO1, CO5, CO6
10	Mini-project – Open application using two or more data structures of the student's choice – Specification, design, implementation and report.	3	CO1, CO5, CO6

Text Book

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, “Introduction to Algorithms”, Fourth Edition, MIT Press, 2022.

Reference Books & web resources

1. Reema Thareja, Data Structures Using C, 3rd Edition, Oxford University Press, 2023.
2. Yashavant Kanetkar, “Data Structures Through C”, Fourth Edition, BPB Publications, 2022.
3. MIT OpenCourseWare – 6.006 Introduction to Algorithms: https://ocw.mit.edu/courses/6-006-introduction-to-algorithms-spring-2020/
4. Mark Allen Weiss, Data Structures and Algorithm Analysis in C, 2nd Edition, Pearson Education, 1996. (Chapter 4)
5. NPTEL – Programming, Data Structures and Algorithms using C: https://nptel.ac.in/courses/106/102/106102064/

Course Designer:

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		Category	L	T	P	Credit
26DSEC0	**OBJECT ORIENTED PROGRAMMING USING C++ LAB**	PCC	0	0	4	2

Preamble

This laboratory course provides hands-on experience in implementing object-oriented programming concepts using C++. Students develop programs based on classes, inheritance, polymorphism, file handling, templates and STL components to solve real-world problems. The course emphasizes modular design, code reusability, and debugging skills while promoting ethical coding practices, clear documentation, and professional communication of program outcomes.

Prerequisite

- 26DSEA0: C Programming Lab

Course Outcomes

On the successful completion of the course, students will be able to

No.	Course Outcome	TPS Level	PI	Objective	SDG	SDG level	PSOs
CO1	Develop C++ programs using classes and objects to implement encapsulation and data abstraction.	3	1.4.1 5.1.1	Design (Cognitive)	4	2	1,2
CO2	Implement constructors, function overloading, and operator overloading to build modular and reusable programs.	3	2.4.1 5.1.1	Experimentation (Cognitive)	4	2	1,2
CO3	Design class hierarchies using inheritance demonstrating runtime polymorphism using virtual functions.	4	1.3.1 5.1.1	Models (Cognitive)	4	2	1,2
CO4	Develop robust C++ applications using templates, exception handling, STL components and file streams	4	1.3.1 5.1.1	Data Analysis (Cognitive)	4	2	1,2
CO5	Write reports demonstrating clear communication of program logic and outcomes.	3	9.1.2	Communication (Affective)	4	2	1
CO6	Follow ethical coding practices including proper documentation, code readability, responsible use of resources, and adherence to academic integrity.	3	7.2.1	Ethics and Integrity (Affective)	8	2	2

Assessment Pattern

Type of Assessment	Component	Marks	Remarks
Continuous Assessment	Pre-lab, In-lab, Post-lab (Cognitive, Affective)	75	Conducted throughout the semester

Model Test	CO-wise (Cognitive)	25	Mid / End semester internal test
Total Internal Marks		**100**	
End Semester Examination	CO-wise (Cognitive)	100	As directed by COE or as per curriculum

List of Experiments

S. No.	Name of the experiment	Level of experiment	COs Addressed
1.	Implementation of classes and objects	2	1,5,6
2.	Use of Static members and functions	2	1,5,6
3.	Manipulating with Array of objects	2	1,5,6
4.	Objects as Function Arguments and return types	2	1,5,6
5.	Constructor overloading and Function overloading	2	2,5,6
6.	Compile time polymorphism with Operator Overloading	2	2,5,6
7.	Aggregation, composition and inheritance	2	3,5,6
8.	Friend Function and Friend Class	2	3,5,6
9.	Use of pointers within classes (this pointer, call and return of objects)	2	3,5,6
10	Abstract class, Virtual function, method overriding with base class and derived class	2	3,5,6
11	Exception handling	2	4.5,6
12	File handling	2	4,5,6
13	Class and function Templates	2	4,5,6
14	STL Containers (Vector, List, Queue, Stack), STL algorithms	2	4,5,6
15	Mini project (Groupwork)	3	1-6

Reference Books & Web resources

1. Bjarne Stroustrup, "The C++ Programming Language", Pearson Education, 4th Edition, 2013.
2. C++ tutorial: https://www.learncpp.com
3. MIT Courseware: https://ocw.mit.edu/courses/6-096-introduction-to-c-january-iap-2011/
4. C++ Practice exercises: https://www.geeksforgeeks.org/cpp/c-plus-plus/

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