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 2023-2024 ONWARDS

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

MADURAI – 625 015, TAMILNADU

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Passed in Board of Studies meeting held on 19-04-2023 Approved in 65th Academic Council meeting on 27-05-2023

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 the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

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 to complex engineering activities with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the

consequent responsibilities relevant to the professional engineering practice.

7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. **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														

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

2023-2024 Onwards
CHOICE BASED CREDIT SYSTEM

Credit Distribution:

S. No.	Category of courses	Credits	Percentage of Credits To TotalCredits
1	Foundation Courses	50	23.70
2	Professional Core Courses- Theory	88	41.70
3	Professional Core Courses- Practical	28	13.27
4	Professional Elective Courses	15	7.11
5	Employability Enhancement Courses	30	14.22
	Total Credits	**211**	100%

Foundation courses (FC):

Course Code	Name Of the Course	Category	No. Of Hours / Week			Credits
			L	T	P	
THEORY						
23DS110	CALCULUS	FC	4	0	0	4
23DS120	FOUNDATIONS OF DATA SCIENCE	FC	4	0	0	4
23DS130	DIGITAL ELECTRONICS AND COMPUTER ORGANIZATION	FC	4	0	0	4
23DS140	PROBLEM SOLVING USING C PROGRAMMING	FC	4	0	0	4
23DS150	DISCRETE STRUCTURES	FC	4	0	0	4
23DS170	C PROGRAMMING LAB	FC	0	0	4	2
23DS210	THEORY OF PROBABILITY	FC	4	0	0	4
23DS230	GRAPH THEORY	FC	4	0	0	4
23DS310	PARTIAL DIFFERENTIAL EQUATIONS AND TRANSFORMS	FC	4	0	0	4
23DS320	ABSTRACT ALGEBRA	FC	4	0	0	4
23DS410	LINEAR ALGEBRA	FC	4	0	0	4
23DS510	NUMERICAL METHODS	FC	4	0	0	4
23DS520	OPTIMIZATION TECHNIQUES	FC	4	0	0	4

Professional Core Courses (PCC):

Course code	Name of the Course	Category	No. of Hours / Week			credits
			L	T	P	
23DS220	APPLIED STATISTICS	PCC	4	0	0	4
23DS240	OBJECT ORIENTED PROGRAMMING	PCC	4	0	0	4
23DS250	ORGANIZATIONAL THEORY AND BEHAVIOUR	PCC	3	0	0	3
23DS270	PYTHON PROGRAMMING AND APPLIED STATISTICS LAB	PCC	0	0	6	3
23DS280	OBJECT ORIENTED PROGRAMMING LAB	PCC	0	0	4	2
23DS330	DATA STRUCTURES	PCC	4	0	0	4
23DS340	DATABASE MANAGEMENT	PCC	4	0	0	4
23DS350	OPERATING SYSTEMS	PCC	3	0	0	3
23DS370	DATA STRUCTURES LAB	PCC	0	0	4	2
23DS380	RELATIONAL DATABASE LAB	PCC	0	0	4	2
23DS420	PREDICTIVE ANALYTICS	PCC	4	0	0	4
23DS430	DESIGN AND ANALYSIS OF ALGORITHMS	PCC	3	1	0	4
23DS440	ADVANCED DATA STRUCTURES	PCC	4	0	0	4
23DS450	SOFTWARE ENGINEERING	PCC	3	0	0	3
23DS470	PREDICTIVE ANALYTICS LAB	PCC	0	0	4	2
23DS480	JAVA PROGRAMMING LAB	PCC	0	0	6	3
23DS530	WEB TECHNOLOGY	PCC	4	0	0	4
23DS540	MACHINE LEARNING	PCC	4	0	0	4
23DS550	COMPUTER NETWORKS	PCC	4	0	0	4
23DS570	WEB TECHNOLOGY LAB	PCC	0	0	4	2
23DS610	DEEP LEARNING	PCC	4	0	0	4

23DS620	DATA MINING	PCC	4	0	0	4
23DS630	BIG DATA SYSTEMS	PCC	4	0	0	4
23DS640	ETHICS FOR DATA SCIENCE	PCC	3	0	0	3
23DS670	DEEP LEARNING LAB	PCC	0	0	4	2
23DS680	BIG DATABASE SYSTEMS LAB	PCC	0	0	4	2
23DS810	REINFORCEMENT LEARNING	PCC	4	0	0	4
23DS820	DATA VISUALIZATION	PCC	4	0	0	4
23DS830	BUSINESS ANALYTICS	PCC	3	1	0	4
23DS870	MATHEMATICAL COMPUTING LAB	PCC	0	0	4	2
23DS880	BUSINESS ANALYTICS AND VISUALIZATION LAB	PCC	0	0	4	2
23DS910	WEB ANALYTICS	PCC	4	0	0	4
23DS920	NATURAL LANGUAGE PROCESSING	PCC	4	0	0	4
23DS930	COMPUTER VISION	PCC	3	1	0	4
23DS970	WEB ANALYTICS LAB	PCC	0	0	4	2
23DS980	NATURAL LANGUAGE PROCESSING LAB	PCC	0	0	4	2

Professional Elective Courses (PEC):

Course code	**Name of the Course**	**Category**	**No. of Hours / Week**			**credits**
			L	**T**	**P**	
23DSPA0	HIGH PERFORMANCE COMPUTING	PEC	3	0	0	3
23DSPB0	MOBILE APPLICATION DEVELOPMENT	PEC	3	0	0	3
23DSPC0	PARALLEL AND DISTRIBUTED COMPUTING	PEC	3	0	0	3
23DSPD0	EMBEDDED SYSTEM	PEC	3	0	0	3
23DSPE0	MARKETING ANALYTICS	PEC	3	0	0	3
23DSPF0	GRAPHICAL MODELS	PEC	3	0	0	3
23DSPG0	SOFT COMPUTING	PEC	3	0	0	3
23DSPH0	MATHEMATICAL MODELING	PEC	3	0	0	3
23DSPJ0	GRAPH ALGORITHMS	PEC	3	0	0	3

23DSPK0	EXPLAINABLE ARTIFICIAL INTELLIGENCE	PEC	3	0	0	3
23DSPL0	GAME THEORY	PEC	3	0	0	3
23DSPM0	SOCIAL MEDIA ANALYTICS	PEC	3	0	0	3
23DSPN0	CLOUD COMPUTING	PEC	3	0	0	3
23DSPP0	DATA VISUALIZATION	PEC	3	0	0	3
23DSPQ0	COMPUTATIONAL FINANCE	PEC	3	0	0	3
23DSPR0	ENTERPRISE INFORMATION SYSTEM	PEC	3	0	0	3
23DSPS0	RANDOMZIED ALGORITHMS	PEC	3	0	0	3
23DSPT0	PRINCIPLES OF MANAGEMENT	PEC	3	0	0	3
23DSPU0	ACCOUNTING AND FINANCIAL MANAGEMENT	PEC	3	0	0	3
23DSPV0	WIRELESS NETWORKS	PEC	3	0	0	3
23DSPW0	NETWORK SCIENCE	PEC	3	0	0	3
23DSPX0	INFORMATION RETRIEVAL	PEC	3	0	0	3

Employability Enhancement Courses (EEC):

Course code	Name of the Course	Category	No. of Hours / Week			credits
			L	T	P	
23DS180	PROFESSIONAL ENGLISH	EEC	0	2	2	3
23DS580	MINI PROJECT	EEC	0	0	6	3
23DSP10	PROJECT WORK I	EEC	0	0	24	12
23DSP20	PROJECT WORK II	EEC	0	0	24	12

Thiagarajar College of Engineering, Madurai – 625 015
Department of Applied Mathematics and Computational Science
Five Year Integrated M.Sc (Data Science) Degree Programme [2023-2024 onwards]
Scheduling of Courses

Sem-ester	Theory					Practical		Credits
1	23DS110 CALCULUS 4:0	23DS120 FOUNDATIONS OF DATA SCIENCE 4:0	23DS130 DIGITAL ELECTRONICS AND COMPUTER ORGANIZATION 4:0	23DS140 PROBLEM SOLVING USING C PROGRAMMING 4:0	23DS150 DISCRETE STRUCTURES 4:0	23DS170 C PROGRAMMING LAB 0:2	23DS180 PROFESSIONAL ENGLISH 0:3	25
2	23DS210 THEORY OF PROBABILITY 4:0	23DS220 APPLIED STATISTICS 4:0	23DS230 GRAPH THEORY 4:0	23DS240 OBJECT ORIENTED PROGRAMMING 4:0	23DS250 ORGANIZATIONAL THEORY AND BEHAVIOR 3:0	23DS270 PYTHON PROGRAMMING AND APPLIED STATISTICS LAB 0:3	23DS280 OBJECT ORIENTED PROGRAMMING LAB 0:2	24
3	23DS310 PARTIAL DIFFERENTIAL EQUATIONS AND TRANSFORMS 4:0	23DS320 ABSTRACT ALGEBRA 4:0	23DS330 DATA STRUCTURES 4:0	23DS340 DATABASE MANAGEMENT 4:0	23DS350 OPERATING SYSTEMS 3:0	23DS370 DATA STRUCTURES LAB 0:2	23DS380 RELATIONAL DATABASE LAB 0:2	23
4	23DS410 LINEAR ALGEBRA 4:0	23DS420 PREDICTIVE ANALYTICS 4:0	23DS430 DESIGN AND ANALYSIS OF ALGORITHMS 3:1	23DS440 ADVANCED DATA STRUCTURES 4:0	23DS450 SOFTWARE ENGINEERING 3:0	23DS470 PREDICTIVE ANALYTICS LAB 0:2	23DS480 JAVA PROGRAMMING LAB 0:3	24
5	23DS510 NUMERICAL METHODS 4:0	23DS520 OPTIMIZATION TECHNIQUES 4:0	23DS530 WEB TECHNOLOGY 4:0	23DS540 MACHINE LEARNING 4:0	23DS550 COMPUTER NETWORKS 4:0	23DS570 WEB TECHNOLOGY LAB 0:2	23DS580 MINI PROJECT 0:3	25
6	23DS610 DEEP LEARNING 4:0	23DS620 DATA MINING 4:0	23DS630 BIG DATA SYSTEMS 4:0	23DS640 ETHICS FOR DATA SCIENCE 3:0	23DSPX0 PROFESSIONAL ELECTIVE I 3:0	23DS670 DEEP LEARNING LAB 0:2	23DS680 BIG DATABASE SYSTEMS LAB 0:2	22
7	23DSP10 PROJECT WORK I - 0:12							12
8	23DS810 REINFORCEMENT LEARNING 4:0	23DS820 DATA VISUALIZATION 4:0	23DS830 BUSINESS ANALYTICS 3:1	23DSPX0 PROFESSIONAL ELECTIVE-II 3:0	23DSPX0 PROFESSIONAL ELECTIVE-III 3:0	23DS870 MATHEMATICAL COMPUTING LAB 0:2	23DS880 BUSINESS ANALYTICS AND VISUALIZATION LAB 0:2	22
9	23DS910 WEB ANALYTICS 4:0	23DS920 NATURAL LANGUAGE PROCESSING 4:0	23DS930 COMPUTER VISION 3:1	23DSPX0 PROFESSIONAL ELECTIVE – IV 3:0	23DSPX0 PROFESSIONAL ELECTIVE – V 3:0	23DS970 WEB ANALYTICS LAB 0:2	23DS980 NATURAL LANGUAGE PROCESSING LAB 0:2	22
10	23DSP20 PROJECT WORK II - 0:12							12
							Total Credits	211

Passed in Board of Studies meeting held on 19-04-2023

Approved in 65th Academic Council meeting on 27-05-2023

Thiagarajar College of Engineering, Madurai

Five year Integrated M.Sc (Data Science) Degree Programme [2023-2024] onwards

Choice Based Credit System

Courses of Study

FIRST SEMESTER

Course code	Course Title	Category	No. of Hours / Week			credits
			L	T	P	
THEORY						
23DS110	CALCULUS	FC	4	-	-	4
23DS120	FOUNDATIONS OF DATA SCIENCE	FC	4	-	-	4
23DS130	DIGITAL ELECTRONICS AND COMPUTER ORGANIZATION	FC	4	-	-	4
23DS140	PROBLEM SOLVING USING C PROGRAMMING	FC	4	-	-	4
23DS150	DISCRETE STRUCTURES	FC	4	-	-	4
PRACTICAL						
23DS170	C PROGRAMMING LAB	FC	-	-	4	2
23DS180	PROFESSIONAL ENGLISH	EEC	-	2	2	3
		TOTAL	20	2	6	25

SECOND SEMESTER

Course code	Course Title	Category	No. of Hours / Week			credits
			L	T	P	
THEORY						
23DS210	THEORY OF PROBABILITY	FC	4	-	-	4
23DS220	APPLIED STATISTICS	PCC	4	-	-	4
23DS230	GRAPH THEORY	FC	4	-	-	4
23DS240	OBJECT ORIENTED PROGRAMMING	PCC	4	-	-	4
23DS250	ORGANIZATIONAL THEORY AND BEHAVIOUR	PCC	3	-	-	3
PRACTICAL						
23DS270	PYTHON PROGRAMMING AND APPLIED STATISTICS LAB	PCC	-	-	6	3
23DS280	OBJECT ORIENTED PROGRAMMING LAB	PCC	-	-	4	2
		TOTAL	19	-	10	24

THIRD SEMESTER

Course code	Course Title	Category	No. of Hours / Week			credits
			L	T	P	
THEORY						
23DS310	PARTIAL DIFFERENTIAL EQUATIONS AND TRANSFORMS	FC	4	-	-	4
23DS320	ABSTRACT ALGEBRA	FC	4	-	-	4
23DS330	DATA STRUCTURES	PCC	4	-	-	4
23DS340	DATABASE MANAGEMENT	PCC	4	-	-	4
23DS350	OPERATING SYSTEMS	PCC	3	-	-	3
PRACTICAL						
23DS370	DATA STRUCTURES LAB	PCC	-	-	4	2
23DS380	RELATIONAL DATABASE LAB	PCC	-	-	4	2
		TOTAL	19	-	8	23

FOURTH SEMESTER

Course code	Course Title	Category	No. of Hours / Week			credits
			L	T	P	
THEORY						
23DS410	LINEAR ALGEBRA	FC	4	-	-	4
23DS420	PREDICTIVE ANALYTICS	PCC	4	-	-	4
23DS430	DESIGN AND ANALYSIS OF ALGORITHMS	PCC	3	1	-	4
23DS440	ADVANCED DATA STRUCTURES	PCC	4	-	-	4
23DS450	SOFTWARE ENGINEERING	PCC	3	-	-	3
PRACTICAL						
23DS470	PREDICTIVE ANALYTICS LAB	PCC	-	-	4	2
23DS480	JAVA PROGRAMMING LAB	PCC	-	-	6	3
		TOTAL	18	1	10	24

FIFTH SEMESTER

Course code	Course Title	Category	No. of Hours / Week			credits
			L	T	P	
THEORY						
23DS510	NUMERICAL METHODS	FC	4	-	-	4
23DS520	OPTIMIZATION TECHNIQUES	FC	4	-	-	4
23DS530	WEB TECHNOLOGY	PCC	4	-	-	4
23DS540	MACHINE LEARNING	PCC	4	-	-	4
23DS550	COMPUTER NETWORKS	PCC	4	-	-	4
PRACTICAL						
23DS570	WEB TECHNOLOGY LAB	PC	-	-	4	2
23DS580	MINI PROJECT	EEC	-	-	6	3
		TOTAL	20	-	10	25

SIXTH SEMESTER

Course code	Course Title	Category	No. of Hours / Week			credits
			L	T	P	
THEORY						
23DS610	DEEP LEARNING	PCC	4	-	-	4
23DS620	DATA MINING	PCC	4	-	-	4
23DS630	BIG DATA SYSTEMS	PCC	4	-	-	4
23DS640	ETHICS FOR DATA SCIENCE	PCC	3	-	-	3
23DSPX0	PROFESSIONAL ELECTIVE I	PEC	3	-	-	3
PRACTICAL						
23DS670	DEEP LEARNING LAB	PCC	-	-	4	2
23DS680	BIG DATABASE SYSTEMS LAB	PCC	-	-	4	2
		TOTAL	18	-	8	22

SEVENTH SEMESTER

Course code	Course Title	Category	No. of Hours / Week			credits
			L	T	P	
PRACTICAL						
23DSP10	PROJECT WORK – I	EEC	-	-	24	12
		TOTAL	-	-	24	12

EIGHTH SEMESTER

Course code	Course Title	Category	No. of Hours / Week			credits
			L	T	P	
THEORY						
23DS810	REINFORCEMENT LEARNING	PCC	4		-	4
23DS820	DATA VISUALIZATION	PCC	4	-	-	4
23DS830	BUSINESS ANALYTICS	PCC	3	1	-	4
23DSPX0	PROFESSIONAL ELECTIVE-II	PEC	3	-	-	3
23DSPX0	PROFESSIONAL ELECTIVE-III	PEC	3	-	-	3
PRACTICAL						
23DS870	MATHEMATICAL COMPUTING LAB	PCC	-	-	4	2
23DS880	BUSINESS ANALYTICS AND VISUALIZATION LAB	PCC	-	-	4	2
		TOTAL	17	1	8	22

NINTH SEMESTER

Course code	Course Title	Category	No. of Hours / Week			credits
			L	T	P	
THEORY						
23DS910	WEB ANALYTICS	PCC	4	-	-	4
23DS920	NATURAL LANGUAGE PROCESSING	PCC	4	-	-	4
23DS930	COMPUTER VISION	PCC	3	1	-	4
23DSPX0	PROFESSIONAL ELECTIVE – IV	PEC	3	-	-	3
23DSPX0	PROFESSIONAL ELECTIVE – V	PEC	3	-	-	3
PRACTICAL						
23DS970	WEB ANALYTICS LAB	PCC	-	-	4	2
23DS980	NATURAL LANGUAGE PROCESSING LAB	PCC	-	-	4	2
		TOTAL	17	1	8	22

TENTH SEMESTER

Course code	Course Title	Category	No. of Hours / Week			credits
			L	T	P	
PRACTICAL						
23DSP20	PROJECT WORK - II	EEC	-	-	24	12
		TOTAL	-	-	24	12

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

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: 211**

Thiagarajar College of Engineering, Madurai

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

SCHEME OF EXAMINATIONS
(For Students admitted in the Academic Year 2023-2024 onwards)

FIRST SEMESTER

Course code	Course Title	Duration of Terminal Exam. in Hrs.	MARKS			Minimum Marks for Pass	
			Continuous Assessment *	Terminal Exam **	Max. Marks	Terminal Exam	Total
THEORY							
23DS110	CALCULUS	3	40	60	100	27	50
23DS120	FOUNDATIONS OF DATA SCIENCE	3	40	60	100	27	50
23DS130	DIGITAL ELECTRONICS AND COMPUTER ORGANIZATION	3	40	60	100	27	50
23DS140	PROBLEM SOLVING USING C PROGRAMMING	3	40	60	100	27	50
23DS150	DISCRETE STRUCTURES	3	40	60	100	27	50
PRACTICAL							
23DS170	C PROGRAMMING LAB	3	60	40	100	18	50
23DS180	PROFESSIONAL ENGLISH	3	60	40	100	18	50

SECOND SEMESTER

Course code	Course Title	Duration of Terminal Exam. in Hrs.	MARKS			Minimum Marks for Pass	
			Continuous Assessment *	Terminal Exam **	Max. Marks	Terminal Exam	Total
THEORY							
23DS210	THEORY OF PROBABILITY	3	40	60	100	27	50
23DS220	APPLIED STATISTICS	3	40	60	100	27	50
23DS230	GRAPH THEORY	3	40	60	100	27	50
23DS240	OBJECT ORIENTED PROGRAMMING	3	40	60	100	27	50
23DS250	ORGANIZATIONAL THEORY AND BEHAVIOUR	3	40	60	100	27	50
PRACTICAL							
23DS270	PYTHON PROGRAMMING AND APPLIED STATISTICS LAB	3	60	40	100	18	50
23DS280	OBJECT ORIENTED PROGRAMMING LAB	3	60	40	100	18	50

THIRD SEMESTER

Course code	Course Title	Duration of Terminal Exam. in Hrs.	MARKS			Minimum Marks for Pass	
			Continuous Assessment *	Terminal Exam **	Max. Marks	Terminal Exam	Total
THEORY							
23DS310	PARTIAL DIFFERENTIAL EQUATIONS AND TRANSFORMS	3	40	60	100	27	50
23DS320	ABSTRACT ALGEBRA	3	40	60	100	27	50
23DS330	DATA STRUCTURES	3	40	60	100	27	50
23DS340	DATABASE MANAGEMENT	3	40	60	100	27	50
23DS350	OPERATING SYSTEMS	3	40	60	100	27	50
PRACTICAL							
23DS370	DATA STRUCTURES LAB	3	60	40	100	18	50
23DS380	RELATIONAL DATABASE LAB	3	60	40	100	18	50

FOURTH SEMESTER

Course code	Course Title	Duration of Terminal Exam. in Hrs.	MARKS			Minimum Marks for Pass	
			Continuous Assessment *	Terminal Exam **	Max. Marks	Terminal Exam	Total
THEORY							
23DS410	LINEAR ALGEBRA	3	40	60	100	27	50
23DS420	PREDICTIVE ANALYTICS	3	40	60	100	27	50
23DS430	DESIGN AND ANALYSIS OFALGORITHMS	3	40	60	100	27	50
23DS440	ADVANCED DATA STRUCTURES	3	40	60	100	27	50
23DS450	SOFTWARE ENGINEERING	3	40	60	100	27	50
PRACTICAL							
23DS470	PREDICTIVE ANALYTICS LAB	3	60	40	100	18	50
23DS480	JAVA PROGRAMMING LAB	3	60	40	100	18	50

FIFTH SEMESTER

Course code	Course Title	Duration of Terminal Exam. in Hrs.	MARKS			Minimum Marks for Pass	
			Continuous Assessment *	Terminal Exam **	Max. Marks	Terminal Exam	Total
THEORY							
23DS510	NUMERICAL METHODS	3	40	60	100	27	50
23DS520	OPTIMIZATION TECHNIQUES	3	40	60	100	27	50
23DS530	WEB TECHNOLOGY	3	40	60	100	27	50
23DS540	MACHINE LEARNING	3	40	60	100	27	50
23DS550	COMPUTER NETWORKS	3	40	60	100	27	50
PRACTICAL							
23DS570	WEB TECHNOLOGY LAB	3	60	40	100	18	50
23DS580	MINI PROJECT	-	50	50	100	25	50

SIXTH SEMESTER

Course code	Course Title	Duration of Terminal Exam. in Hrs.	MARKS			Minimum Marks for Pass	
			Continuous Assessment *	Terminal Exam **	Max. Marks	Terminal Exam	Total
THEORY							
23DS610	DEEP LEARNING	3	40	60	100	27	50
23DS620	DATA MINING	3	40	60	100	27	50
23DS630	BIG DATA SYSTEMS	3	40	60	100	27	50
23DS640	ETHICS FOR DATA SCIENCE	3	40	60	100	27	50
23DSPX0	PROFESSIONAL ELECTIVE I	3	40	60	100	27	50
PRACTICAL							
23DS670	DEEP LEARNING LAB	3	60	40	100	18	50
23DS680	BIG DATABASE SYSTEMS LAB	3	60	40	100	18	50

SEVENTH SEMESTER

Course code	Course Title	Duration of Terminal Exam. in Hrs.	MARKS			Minimum Marks for Pass	
			Continuous Assessment *	Terminal Exam **	Max. Marks	Terminal Exam	Total
PROJECT WORK I							
23DSP10	PROJECT WORK - I	-	150	150	300	75	150

EIGHTH SEMESTER

Course code	Course Title	Duration of Terminal Exam. in Hrs.	MARKS			Minimum Marks for Pass	
			Continuous Assessment *	Terminal Exam **	Max. Marks	Terminal Exam	Total
THEORY							
23DS810	REINFORCEMENT LEARNING	3	40	60	100	27	50
23DS820	DATA VISUALIZATION	3	40	60	100	27	50
23DS830	BUSINESS ANALYTICS	3	40	60	100	27	50
23DSPX0	PROFESSIONAL ELECTIVE-II	3	40	60	100	27	50
23DSPX0	PROFESSIONAL ELECTIVE-III	3	40	60	100	27	50
PRACTICAL							
23DS870	MATHEMATICAL COMPUTING LAB	3	60	40	100	18	50
23DS880	BUSINESS ANALYTICS AND VISUALIZATION LAB	3	60	40	100	18	50

NINTH SEMESTER

Course code	Course Title	Duration of Terminal Exam. in Hrs.	MARKS			Minimum Marks for Pass	
			Continuous Assessment *	Terminal Exam **	Max. Marks	Terminal Exam	Total
THEORY							
23DS910	WEB ANALYTICS	3	40	60	100	27	50
23DS920	NATURAL LANGUAGE PROCESSING	3	40	60	100	27	50
23DS930	COMPUTER VISION	3	40	60	100	27	50
23DSPX0	PROFESSIONAL ELECTIVE – IV	3	40	60	100	27	50
23DSPX0	PROFESSIONAL ELECTIVE – V	3	40	60	100	27	50
PRACTICAL							
23DS970	WEB ANALYTICS LAB	3	60	40	100	18	50
23DS980	NATURAL LANGUAGE PROCESSING LAB	3	60	40	100	18	50

TENTH SEMESTER

Course code	Course Title	Duration of Terminal Exam. in Hrs.	MARKS			Minimum Marks for Pass	
			Continuous Assessment *	Terminal Exam **	Max. Marks	Terminal Exam	Total
PROJECT WORK II							
23DSP20	PROJECT WORK - II	-	150	150	300	75	150

*** 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 300 and subsequently be reduced to 150 marks for the award of terminal examination marks**

		Category	L	T	P	Credits
23DS110	**CALCULUS**	FC	4	0	0	4

Preamble

This course will enable students to analyse the behaviour of functions of single and multi-variables to solve complex engineering problems, applications of multiple integrals in various real-life problems. Also, the students will learn the nature of the sequence and series in the technical problems.

Prerequisite

Nil

Course Outcomes

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

CO1	Explain the concept of Differentiation and Integration	Understand
CO2	Apply the concepts of maxima and minima for a given function with several variables, through finding stationary points and Lagrangian multiplier method for finding Maxima and Minima of a constrained problem.	Apply
CO3	Apply the suitable method to solve second and higher order Differential equations.	Apply
CO4	Apply integration concept and double integral over general Areas	Apply
CO5	Apply integration concept and triple integral over general volumes to find mass and moments.	Apply
CO6	Apply sequences and Series in the problems involving Science and Engineering with the knowledge of convergence and divergence of series using different tests.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L	L	L	M	-	-	-	-	-	-	-	L	L	M
CO2	S	S	M	M	-	-	-	-	-	-	-	M	L	S
CO3	S	S	M	M	L	-	-	-	-	-	-	M	L	S
CO4	S	S	M	S	L	-	-	-	-	-	-	M	L	S
CO5	S	S	M	S	L	-	-	-	-	-	-	M	L	S
CO6	S	S	L	L	-	-	-	-	-	-	-	L	L	S

S- Strong; M-Medium; L-Low

Assessment Pattern

CO	CAT1						Assignment 1						CAT2						Assignment2						Terminal					
Bloom's level	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
CO1	5	20																							2	10	-			
CO2	5	10	30						50																2	-	20			
CO3			30						50																2	5	10			
CO4													5	10	20						30				2	-	10			
CO5													5	10	20						40				-	-	20			
CO6														10	20						30				2	5	10			
Total (in %)	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. Applications of multiple integrals.

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.

Reference Books and Web Resources:

1. Hass M. D. J., Giordano Weir F.R., "Thomas Calculus", Pearson Education,14th edition, 2018.
2. Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley & Sons, 2014.
3. Lian, Hungerford, and Holcomb "Mathematics with Applications", Addison Wesley, 2010.
4. Michael D. Greenberg, "Advanced Engineering Mathematics", Pearson Education, 2013.
5. http://calculus.org
6. https://www.khanacademy.org/math/calculus-1
7. https://dlmf.nist.gov
8. https://www.siam.org/

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.	2

Module No.	Topic	No. of Periods
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.	2
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.	2
4	**Multiple Integrals: Double Integrals**	
4.1	Double integrals in Cartesian form – Problems.	3
4.2	Change of order of integration - Problems.	2
4.3	Double integrals in polar form – Problems.	2
4.4	Triple integrals in Cartesian form – Problems.	3
4.5	Change of variable in triple integrals into polar – Problems.	2
4.6	Spherical and cylindrical co-ordinates. Applications of multiple integrals– Problems.	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	44

Course Designer(s):

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Dept. of Applied Mathematics and Computational Science

23DS120	FOUNDATIONS OF DATA SCIENCE	Category	L	T	P	Credit
		FC	4	0	0	4

Preamble

Data science is an interdisciplinary field that draws on skills from mathematics, computer science, and statistics. This course will enable students to learn the fundamental concepts circumventing data science, and its applications.

Prerequisite

NIL

Course Outcomes

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

CO1	Describe the taxonomy of Data	Understand
CO2	Explore the current practices in Data Analytics	Understand
CO3	Identify the key roles for the Data Ecosystem	Understand
CO4	Identify the key roles for a successful analytics project	Understand
CO5	Apply the Data Analytics Life Cycle components to data science projects.	Apply
CO6	Apply data preparation and modelling techniques to data science related problem specifications.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	L	-	-	-	-	-	-	-	-	-	-	M	L
CO2	M	L	-	-	-	-	-	-	-	-	-	-	M	L
CO3	M	L	-	-	-	-	-	-	-	-	-	-	M	L
CO4	M	L	M	-	-	-	-	-	-	-		-	M	L
CO5	S	S	M	-	-	-	-	-	-	-	-	-	M	L
CO6	S	S	L	-	-	-	-	-	-	-	-	-	M	L

S- Strong; M-Medium; L-Low

Assessment Pattern

CO	CAT1						Assignment 1						CAT2						Assignment2						Terminal					
Bloom's level	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
CO1	5	20																							4	10				
CO2	10	25						50																	4	10				
CO3	15	25						50																	4	10				
CO4													10	10											4	10				
CO5													5	10	20						50				2		20			
CO6													5	10	30						50				2		20			
Total (in %)	100						100						100						100						100					

Syllabus

Taxonomy of Data: Basics of Data Structures **-** Overview of Big Data –Introduction to analytics - Data Repositories.

State of the Practice in Analytics- BI versus Data science, Current Analytical Architecture, Drivers of Big Data, Emerging big data ecosystem and new approach to analytics.

Key Roles for the New Big Data Ecosystem- Deep Analytical Talent, Data Savvy Professional, Technology and Data Enablers, Data Scientist, Examples of Big Data Analytics.

Data Analytics- Overview - Analytics in a Data Science Project - Key roles for a successful analytics project.

Data Analytics Life Cycle (DALC) – Overview- Different phases in a DALC **- Phase I Discovery**- Learning the Business Domain, Resources, Framing the Problem, Identifying key stakeholders, Interviewing the Analytics Sponsor, Developing initial hypotheses, Identifying potential data Sources.

Phase II-Data Preparation- Preparing the analytic Sandbox, Performing ETLT, Learning about the data, Data conditioning, Survey and Visualize data using common tools for the Data Visualization Phase.

Phase III-Model Planning- Data exploration and variable selection, Model selection, Common tools for the model planning phase.

Phase IV-Model Building- Common tools for the model building phase, **Phase V-Communicate Results, Phase VI-Operationalize.**

Case Studies on Applications of Data Science and Data Analytics

Reference Books

1. Wiley., Dietrich, D., Heller, B., & Yang, B, “Data science & big data analytics: discovering, analyzing, visualizing and presenting data”, Wiley, First Edition, 2015.

2. Eliot P. Rezno, “Big Data: A Beginner's Guide to Using Data Science for Business”, CreateSpace Independent Publishing Platform, 2017.

3. Fahl, J, “Data Analytics: A Practical Guide To Data Analytics For Business, Beginner To Expert” , CreateSpace Independent Publishing Platform , 2017.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Periods
1	**Taxonomy of Data**	1
1.1	Basics of Data Structures	1
1.2	Overview of Big Data	1
1.3	Introduction to analytics	1
1.4	Data Repositories	1

Module No.	Topic	No. of Periods
2	**State of the Practice in Analytics**	
2.1	BI versus Data science	1
2.2	Current Analytical Architecture	2
2.3	Drivers of Big Data	1
2.4	Emerging big data ecosystem and new approach to analytics	2
3	**Key Roles for the New Big Data Ecosystem**	
3.1	Deep Analytical Talent	2
3.2	Data Savvy Professional	1
3.3	Technology and Data Enablers	1
3.4	Data Scientist	1
3.5	Examples of Big Data Analytics	1
4	**Data Analytics**	
4.1	Overview	1
4.2	Analytics in a Data Science Project	1
4.3	Key roles for a successful analytics project	1
5	**Data Analytics Life Cycle (DALC)**	
5.1	Overview	1
5.2	Different phases in a DALC	1
6	**Phase I Discovery**	1
6.1	Resources	1
6.2	Framing the Problem	1
6.3	Identifying key stakeholders	1
6.4	Interviewing the Analytics Sponsor	1
6.5	Developing initial hypotheses	1
6.6	Identifying potential data Sources	1
7	**Phase II-Data Preparation**	1
7.1	Preparing the analytic Sandbox	1
7.2	Performing ETLT	1
7.3	Learning about the data, Data conditioning	2

Module No.	Topic	No. of Periods
7.4	Survey and Visualize data using common tools for the Data Visualization Phase.	2
8	**Phase III-Model Planning**	1
8.1	Data exploration and variable selection	2
8.2	Model selection	1
8.3	Common tools for the model planning phase	1
9	**Phase IV-Model Building**	1
9.1	Common tools for the model building phase	1
10	**Phase V-Communicate Results,**	2
11	**Phase VI-Operationalize.**	2
12	**Case Studies on Applications of Data Science and Data Analytics**	2
	Total	**45**

Course Designer(s):

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		Category	L	T	P	Credit
23DS130	**DIGITAL ELECTRONICS AND COMPUTER ORGANIZATION**	FC	4	0	0	4

Preamble

This course will enable students to focus on the design and analysis of electronic circuits, understand the computer hardware and software components, their interactions and perform various computational tasks.

Prerequisite

Nil

Course Outcomes

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

CO1	Summarize the aspects of digital electronics in the design of simple and advanced computer architectures	Understand
CO2	Design combinational and sequential logic circuits, including adders, subtractors, encoders, decoders, multiplexers, de-multiplexers, flip-flops, counters, and shift registers.	Apply
CO3	Implement number systems and codes with appropriate number representations to perform arithmetic operations	Apply
CO4	Apply fundamental concepts of digital logic design in implementing Arithmetic and Logic unit	Apply
CO5	Demonstrate the design of control unit with micro instructions	Apply
CO6	Design input/output organizations using interrupts, DMA to fetch instructions in memory	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M	-	-	-	-	-	-	-	-	-	-	L	L
CO2	S	M	-	-	-	-	-	-	-	-	-	-	L	L
CO3	S	M	-	-	-	-	-	-	-	-	-	-	L	L
CO4	S	M	M	-	-	-	-	-	-	-	-	-	L	L
CO5	S	M	L	-	-	-	-	-	-	-	-	-	L	L
CO6	S	M	L	-	-	-	-	-	-	-	-	-	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern

CO	CAT1						Assignment 1						CAT2						Assignment2						Terminal					
Bloom's level	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
CO1	5	20												10											2					
CO2	5	10	30						50																2		5			
CO3		10	20						50																2	5	20			
CO4													5	10	20						30				2	5	15			
CO5													5	10	15						40				2	5	20			
CO6														10	15						30					5	10			
Total (in %)	100						100						100						100						100					

Syllabus

DIGITAL SYSTEMS:

Number Systems and Codes:

Binary, Hexadecimal, Octal, BCD, 2421, Excess – 3, Gray

Digital Circuits and Gates:

Logical gates,TTL and MOS logic circuits

Combinational Logic:

Design and implementation of Half and Full adders, Encoders and decoders, Multiplexers and De-multiplexers

Sequential Logic:

R-S, J-K, and D Type Flip-Flops,Moore/Mealy models

Binary counters:

Ripple and synchronous types, Shift registers

COMPUTER ORGANIZATION

Functional Units and Bus Structures

Basic operational concepts, Bus structures

Machine Instructions and Addressing Modes -Machine instructions, Addressing modes

Arithmetic Operations- Number representations, operations of signed numbers, Addition, Multiplication and division operation

Processing Unit and ALU -Concepts of processing unit, Execution of complete instruction, Multi bus organization, Arithmetic and Logic Unit (ALU)- Adders, Fast adders, Multiplication and Division circuits

Control Unit – Control units type, Hardwired control, Microprogrammed - Micro instructions, Micro program sequencing, Micro instructions types

Memory: Memory units, memory types - efficiency

Input and Output Organization -Accessing I/O devices,Interrupts,Direct Memory Access (DMA),Interface circuits

Advanced Processor Architecture- RISC,Pipelining,Super scalar processors,VLIW,Parallel and vector processors

Reference Books

1. Leach D.P., “Digital Principles & Application”, Tata McGraw Hill, 2014.
2. William Stallings, “Computer Organization and Architecture”, Eleventh Edition, Pearson Education, 2022.
3. Carl Hamacher, Zvonko Vranesic, safwat Zaky, “Computer Organization and Embedded System”, Sixth Edition, Tata McGraw Hill, 2022.
4. David A. Patterson, John L.Hennessy, “Computer Organization and Design”, Fourth Edition, Morgan Kauffmann Publishers, 2020.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Periods
1	**Digital Systems - Introduction**	
1.1	Fundamental aspects of semiconductors	1
2	**Number Systems and Codes**	
2.1	Binary	1
2.2	Hexadecimal	1
2.3	BCD, Gray, Excess-3, 2421	1
3	**Digital Circuits ,Gates and Combinational Logic:**	
3.1	AND, OR, NOT gates	2
3.2	TTL and MOS logic circuits	2
3.3	Design and implementation of Half and Full adders	1
3.4	Encoders and decoders	1
3.5	Multiplexers and De-multiplexers	1
4	**Sequential Logic**	
4.1	R-S, J-K, and D type Flip-Flops	1
4.2	Binary counters: Ripple and synchronous types	1
4.3	Shift registers	1
5	**Computer architecture**	
5.1	Basic operational concepts and functional units	1
5.2	Bus structures	1
5.3	Machine instructions	1
5.4	Addressing modes	1
6	**Design of ALU**	
6.1	Number representations	1
6.2	Addition and subtraction of signed numbers	1
6.3	Design of fast adders	1
6.4	Multiplication of signed numbers	1
6.5	Fast multiplication	1
6.6	Integer division	1

Module No.	Topic	No. of Periods
6.7	Concepts of processing unit	1
6.8	Execution of complete instruction	1
6.9	Multi bus organization	1
7	**Control Unit and Memory**	
7.1	Hardwired control	1
7.2	Micro programmed control	1
7.3	Micro instructions	1
7.4	Micro program sequencing	1
7.5	Micro instructions with next address field and pre-fetching	1
7.6	RAM and ROM	2
7.7	Cache memories and Virtual Memory	2
8	**Input & Output Organization**	
8.1	Accessing I/O devices	1
8.2	Interrupts	1
8.3	Direct Memory Access (DMA)	1
8.4	Interface circuits	1
9	**Advanced Processor Architecture**	
9.1	RISC	1
9.2	Pipelining	1
9.3	Super scalar processors, VLIW, Parallel and vector processors	2
	Total	44

Course Designer(s):

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23DS140	PROBLEM SOLVING USING C PROGRAMMING	Category	L	T	P	Credit
		FC	4	0	0	4

Preamble

The course aims to provide exposure to problem-solving through C programming. It aims to train the students on the basic concepts of the C-programming language with appropriate problems that reflects users' simple computing requirements

Prerequisite

Nil

Course Outcomes

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

CO1	Explain the basic constructs of programming languages	Understand
CO2	Given a computational problem, abstract the programming task involved with algorithm and flowchart	Apply
CO3	Write C programs with suitable operators and control flow statements for given user requirements.	Apply
CO4	Develop C programs with arrays and pointers in the context of functions with an understanding on the basic constructs of a programming language involving character and string functions	Apply
CO5	Apply the concept of structures and unions in developing application-oriented program in C	Apply
CO6	Develop C programs for user requirements with file operations	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M	L	-	S	-	-	-	-	-	-	-	L	L
CO2	S	M	L	-	S	-	-	-	M	-	-	-	M	M
CO3	S	M	L	-	S	L	L	-	M	-	-	-	M	M
CO4	S	M	L	-	S	L	L	-	M	-	-	-	M	M
CO5	S	M	L	-	S	L	L	-	M	-	-	-	M	M
CO6	S	M	L	-	S	L	L	-	M	-	-	-	M	M

S- Strong; M-Medium; L-Low

Assessment Pattern

CO	CAT1						Assignment 1						CAT2						Assignment2						Terminal					
Bloom's level	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
CO1	10	5																							5	5				
CO2	5	5	20						50																5		10			
CO3	5	10	20						25																	5	15			
CO4			20						25				5		20						40				5		15			
CO5													10	10	20						30					10	10			
CO6													5	10	20						30				5		10			
Total (in %)	100						100						100						100						100					

Syllabus

Computing and problem solving: Fundamentals of Computing, Algorithms, Pseudocode and flowcharts. Role of programming languages, Memory, Variables, Values, Instructions, Programs, The Role of Programming Languages, Structured Programming.

Types, operators and expressions: Variables, Data types – constants – Declarations – Storage classes - Arithmetic, relational and logical operators - Type conversions – Increment, Decrement and bitwise operators – Assignment operators and expressions - conditional expressions – Precedence and order of evaluation – 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 – Practice problems

Pointers and Arrays: Basic of pointers and arrays - Pointer Arithmetic - Pointers to array - Pointers to function - Multidimensional arrays and pointers –Practice problems

Structures and Unions: Motivation and examples – Structures and functions – Array of structures – Pointer to structures – Self-referential structures – Dynamic allocation - Table lookup – Unions – Bit fields - Practice problems

I/O Management: Input and output from console – Standard input – Formatted output – Variable length argument lists – Formatted input - File Management in C – File access – Error handling - Practice problems

Reference Books

1. Byron S Gottfried,"Programming with C", 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 Education, 2018
4. Reema Thareja "Computer fundamentals and programming in C", Oxford University, Second edition, 2017
5. Brian W Kernighan & Dennis Ritchie, "The C programming language", 2nd Edition, Prentice Hall , 2015

Course Contents and Lecture Schedule

Module No.	Topic	No. of Periods
1	**Introduction to computing and problem solving**	
1.1	Fundamentals of Computing, Algorithms, Pseudo-code and flowcharts	1
1.2	Role of programming languages, Memory, Variables, Values, Instructions, Programs	1
1.3	Structured Programming	1
2	**Types, operators and expressions:**	
2.1	Variables and Data types , constants	1

Module No.	Topic	No. of Periods
2.2	Arithmetic, relational and logical operators	1
2.3	Type conversions	1
2.4	Increment, Decrement and bitwise operators	1
2.5	Assignment operators	1
2.6	conditional expressions	1
2.7	Precedence and order of evaluation	1
2.8	Practice problems	1
3	**Control flow:**	
3.1	Statements and blocks	1
3.2	Decision control structures	1
3.3	Looping control structures	1
3.4	Case control structures	1
3.5	Practice problems	1
4	**Functions and Program Structure:**	
4.1	Basics	1
4.2	Function Prototyping	1
4.3	Function Call by value	1
4.4	Function Call by reference	1
4.5	Recursion	1
4.6	Practice problems	1
5	**Pointers and Arrays:**	
5.1	Basic of pointers and arrays	1
5.2	Pointers to array	1
5.3	Pointers to function	1
5.4	Multidimensional arrays and pointers	1
5.5	Practice problems	1
6	**Structures and Unions:**	
6.1	Motivation and examples	1
6.2	Structures and functions	1
6.3	Array of structures	1
6.4	Self-referential structures	1
6.5	Pointer to structures	1
6.6	Dynamic allocation	1
6.7	Unions	1
6.8	Practice problems	2
7	**I/O Management:**	
7.1	Input and output from console	1

Module No.	Topic	No. of Periods
7.2	Standard input and Formatted output	1
7.3	Variable length argument lists	1
7.4	Formatted input	1
7.5	File Management in C	1
7.6	File access	1
7.7	Error handling	1
7.8	Practice problems	1
	Total	44

Course Designer(s):

Ms. P. Sharmila, psaca@tce.edu
Assistant Professor in Data Science,
Dept. of Applied Mathematics and Computational Science

		Category	L	T	P	Credit
23DS150	**DISCRETE STRUCTURES**	FC	4	0	0	4

Preamble

This course will provide an outline to equivalent logical proposition for a real-world statement by applying predicates and quantifiers and to develop fundamental knowledge of combinatorics. This course also helps to apply the Laws using Lattices and Boolean algebra and prove the properties and construct the Automata to reduce the complexity of a model.

Prerequisite

Nil

Course Outcomes

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

CO1	Prove implication problems using truth table method, truth table technique, rules of inference to obtain PCNF and PDNF of given logical expression.	Apply
CO2	Construct verbal arguments with predicates in symbolic form after validating them using inference	Apply
CO3	Represent the different types of relation in matrix, digraph and vice versa.	Apply
CO4	Prove using mathematical induction and problems using permutations and combinations.	Apply
CO5	Prove the properties of Lattices and Boolean algebra.	Apply
CO6	Construct DFA and NFA with given language considering the grammar	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1.	L	L	L	M	M	M	-	-	-	-	-	-	L	M
CO2.	S	S	M	M	-	M	-	-	-	-	-	-	L	S
CO3	S	S	M	M	-	-	-	-	-	-	-	-	L	S
CO4	S	S	M	S	M	M	-	-	-	-	-	-	L	S
CO5	S	S	M	S	M	-	-	-	-	-	-	-	L	S
CO6	S	S	L	L	M	M	-	-	-	-	-	-	L	S

S- Strong; M-Medium; L-Low

Assessment Pattern

CO	CAT1						Assignment 1						CAT2						Assignment2						Terminal					
Bloom's level	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
CO1	5	10	20						40																	5	16			
CO2	5		20						30																2		8			
CO3		10	30						30																2	5	8			
CO4													5	10	30						40				2	5	12			
CO5													5	10	20						30				2	5	16			
CO6															20						30				2		10			
Total (in %)	100						100						100						100						100					

Syllabus

Mathematical logic:

Propositional Logic: Introduction, Connectives. Tautology and Contradiction. Logical Equivalences and Logical Implications. Normal forms: CNF, DNF, PCNF, PDNF. Theory of Inferences - Rules of Inference – Consistency of premises. Validity by truth table technique.

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

Set Theory:

Relations: 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. **Functions**: Types, Composition of functions, Inverse of a function, Recursive functions.

Combinatorics:

Mathematical Induction. Basics of Counting. Pigeonhole Principle. Permutations and Combinations. Recurrence relations. Principle of Inclusion and Exclusion.

Lattices & Boolean Algebra:

Lattices – Principle of Duality - Properties of lattices, Sub lattices, Special lattices. Properties of Boolean algebra – Dual and Principle of Duality – Sub algebra. Boolean Homomorphism, Expressions and Functions.

Grammar and Automata Theory:

Grammar: Phrase-Structure Grammars - Types of Grammar.

Automata Theory: Overview of Finite - State Machine, Input and Output strings of FSM, Finite State Automata, Pushdown Automaton, Turing Machine. Pumping Lemma.

Reference Books and Web Resources

1. Kenneth H. Rosen, “Discrete mathematics and its applications”, McGraw-Hill International Editions, 2021.
2. Trembly and Manohar, “Discrete mathematical structures with applications to Computer Science”, Tata McGraw-Hill, 2017.
3. John E. Hopcraft, Rajeev Motwani, Jeffery D. Ullman, “Introduction to Automata Theory, Languages and Computation”, Pearson Education, Asia, 3rd edition, 2013.
4. Judith L. Gersting, “Mathematical Structures for Computer Science”, W.H. Freeman and Company, 2014.
5. http://www.discrete-math-hub.com/resources-and-help.html#otherstuff
6. https://en.wikibooks.org/wiki/Discrete_Mathematics
7. https://mathworld.wolfram.com/

Course Contents and Lecture Schedule

Module No.	Topic	No. of Periods
1	Mathematical logic	
1.1	Propositional Logic Introduction, Connectives	1
1.2	Tautology and Contradiction	1
1.3	Logical Equivalences and Logical Implications	1
1.4	Normal forms: CNF, DNF, PCNF, PDNF	2
1.5	Theory of Inferences - Rules of Inference – Consistency of premises. Validity by truth table technique	2
1.6	Predicate Calculus Predicates - Statement Function	1
1.7	Variables and Quantifiers	1
1.8	Theory of inferences of Predicate Calculus	2
2	Set Theory	
2.1	Relations: Binary relations, Equivalence relations and Partitions	1
2.2	Matrix representation of a relation, relation representation by graphs.	2
2.3	Partially ordered set (PO Set), Hasse Diagram, LUB, GLB.	2
2.4	Functions: Types, Composition of functions,	1
2.5	Inverse of a function, Recursive functions.	2
3	Combinatorics	
3.1	Mathematical Induction	1
3.2	Basics of Counting. Pigeonhole Principle.	2
3.3	Permutations and Combinations	2
3.4	Recurrence relations.	2
3.5	Principle of Inclusion and Exclusion.	2
4	Lattices & Boolean Algebra	
4.1	Lattices – Principle of Duality	1
4.2	Properties of lattices, Sub lattices, Special lattices	2

4.3	Properties of Boolean algebra – Dual and Principle of Duality	2
4.4	Sub algebra	1
4.5	Boolean Homomorphism, Expressions and Functions.	2
5	Grammar and Automata Theory	
5.1	Grammar: Phrase-Structure Grammars - Types of Grammar.	1
5.2	Automata Theory: Overview of Finite-state Machine	1
5.3	Input and Output strings of FSM	2
5.4	Finite State Automata, Pushdown Automaton	2
5.5	Turing Machine. Pumping Lemma.	2
	Total	44

Course Designer(s):

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Assistant Professor in Data Science,
Dept. of Applied Mathematics and Computational Science.

23DS170 C PROGRAMMING LAB	Category	L	T	P	Credit
	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

CO1	Implement C programs by choosing suitable datatypes and apply the concept of Control Structures to solve any given problem	Apply
CO2	Apply the concept of single and multi-dimensional arrays to solve problems related to searching, sorting and matrix operations.	Apply
CO3	Develop C programs using the concept of user-defined and recursive functions.	Apply
CO4	Develop C Programs by applying the concept of structures and unions	Apply
CO5	Implement C programs for demonstrating pointer concepts.	Apply
CO6	Implement C programs to create and process data files.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1.	S	S	S	L	L	L	L	-	L	L	L	L	L	L
CO2.	S	S	S	L	L	L	L	-	L	L	L	L	L	L
CO3	S	S	S	L	L	L	L	-	L	L	L	L	L	L
CO4	S	S	S	L	L	L	L	-	L	L	L	L	L	L
CO5.	S	S	S	L	L	L	L	-	L	L	L	L	L	L
CO6	S	M	M	L	L	L	L	-	L	L	L	L	L	L

S- Strong; M-Medium; L-Low

List of Experiments

1. Simple programs to demonstrate data types and storage classes
2. Familiarizing conditional, control and looping statements.
3. Usage of single and double dimensional arrays
4. Implementation of functions and recursive functions (call by value and reference)
5. Defining and handling structures, array of structures and union.
6. Implementation of pointers- operation on pointers and pointer arithmetic
7. Implementation of dynamic storage allocation.
8. Creating and processing data files.

Reference Books

1. Yashavant Kanetkar, “Let Us C : Authentic guide to C programming language” , 18th Edition, BPB Publications, 2021.
2. Brian W Kernighan & Dennis Ritchie, ”The C programming language”, 2nd Edition, Prentice Hall ,2015 Chapters 1,2,3,4,5,6,7
3. H. M. Deitel, P. J. Deitel, “C: How to program”, 7th edition, Pearson Education, 2010. Chapter 13
4. R. G. Dromey, "How to Solve It By Computer", 12 th Edition, Pearson Education, 2007
5. Darnell and Margolis, ”ANSI C- A Systematic programming Approach” Narosa publications, 2010.

Course Designer:

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Department of Applied Mathematics and Computational Science.

23DS180 PROFESSIONAL ENGLISH

Category	L	T	P	Credit
EEC	0	2	2	3

Preamble

The course will equip the students to apply knowledge and language skills to thrive in the digital era where data and information are recognized as pivotal to the academic, professional, and social life.

Prerequisite

Nil

Course Outcomes

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

CO1	Associate the meaning with its vocabulary	Understand
CO2	Adapt practical techniques to listen and comprehend various speeches with the required emphasis	Apply
CO3	Read for Comprehending various texts	Understand
CO4	Express their ideas clearly and effectively in both spoken and written communication	Apply
CO5	Explore critically and analytically about common social issues	Apply
CO6	Discover a spirit of inquiry	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1									S	S			L	L
CO2									S	S			L	L
CO3									S	S			L	L
CO4									S	S			L	L
CO5									S	S			L	L
CO6									S	S			L	L

S- Strong; M-Medium; L-Low

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 60 marks as detailed below

Listening Test	-	10
Speaking Test- Presentation /Brainstorming	-	25
Written Test (Basic Grammar and Paragraph Writing)	-	25

External (Practical)

Listening	- 20
Speaking (Presentation)	- 20
Brain storming on Social Issues	- 10
Writing	- 50

(Vocabulary Building, Synonyms and Antonyms, One-word Substitutions, Idioms & Phrases, SV Agreement, Tenses, Voices, Prepositions, Adjectives and Adverbs)

Syllabus

Module 1: Basic Grammar – Subject Verb Agreement, Tenses / Voices, Preposition, Adjectives and Adverbs

Module 2 : Vocabulary Building- Synonyms and Antonyms, One Word Substitution, Idioms & Phrases

Module 3 : Listening Skill – Listening to various TED talks and Documentaries

Module 4 : Speaking Skill – SWOT Analysis, Elevator Pitch, Brainstorming on various social issues, Presentation Strategy, Presentation using various digital tools, Facing and handling difficult questions

Module 5 : Reading Skill – Skipping, skimming, scanning , Intensive reading, Reading comprehension
Extensive Reading – 'The Power of Positive Thinking' by Norman Vincent Peale

Module 6 : Writing Skill - Coherent markers, Logical Sequence of Sentences and Paragraphs, Interpretation of Graphics, Writing Agenda & Minutes

Reference Books and web resources

1. Courseware on "Technical Communication for Scientists and Engineers", IIT Bombay,2015.
2. Lewis, Norman. "How to Read better & Faster". New Delhi: Binny Publishing House. 1978
3. McCarthy, Michael and Felicity O'Dell. "English vocabulary in use : 100 Units of Vocabulary reference and practice" in Cambridge: CUP. 1996
4. N.M. White, " Unlock – Listening and Speaking Skills 1" Cambridge University Press, 2014
5. https://www.ted.com/talks
6. "Elephant Whisperers" – Documentary, 2022
7. Online YouTube videos on Current Issues

Extensive Reading – Norman Vincent Peale, "The Power of Positive Thinking", Readers' Paradise, 2020

Course Contents and Lecture Schedule

Module No.	Topic	No. of Periods	
		Tutorials	Lab
1	**Basic Grammar**		1
1.1	Tenses / Voices	1	
1.2	Subject Verb Agreement	1	
1.3	Preposition	1	
1.4	Adjectives and Adverbs	1	

2	**Vocabulary Building**		2
2.1	Synonyms and Antonyms	1	
2.2	One word substitution	1	
2.3	Idioms and Phrases	2	
3	**Listening Skills**		
3.1	Listening to TED Talks and Documentaries		4
4	**Speaking Skills**		
4.1	SWOT Analysis	1	1
4.2	Elevator Pitch (Video Recording)	1	2
4.3	Brainstorming on various social issues	2	2
4.4	Presentation Strategy, Facing and handling difficult questions	2	2
4.5	Preparing presentation using various digital tools		4
5	**Reading Skills**		
5.1	Skimming, skipping and scanning , and Intensive Reading Skills	2	
5.2	Reading Comprehension	1	2
6	**Writing Skills**		
6.1	Coherent Markers, Logical Sequence of Sentences and Paragraphs	2	
6.2	Paragraph Writing	1	
6.3	Interpretation of Graphics	2	
6.4	Writing Agenda and Minutes	2	
	Practice Test on LSRW Skills		4
		24	24
	Total	**48 hours**	

Course Designer(s):

1. Dr.A.Tamilselvi, Professor, Department of English — tamilselvi@tce.edu
2. Dr.RS.Swarnalakshmi, Assistant Professor, Department of English — rssleng@tce.edu

		Category	L	T	P	Credit
23DS210	**THEORY OF PROBABILITY**	FC	4	0	0	4

Preamble

This course will enable students to apply conditional probability, Bayes' theorem to solve real time problems and to learn the concepts of moment generating functions to discrete and continuous distributions and find the probability values for the defined distributions. Also, the course enables them to learn the concepts of Limit theorems and realize the applications of central limit theorem

Prerequisite

Nil

Course Outcomes

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

CO1	Apply the concepts of basics of probability, conditional Probability and Bayes' Theorem to solve the real world problems	Apply
CO2	Infer discrete and continuous random variables, probability mass function and density function, expectation and variance	Apply
CO3	Apply the concepts of discrete and continuous distributions as binomial, Bernoulli, Poisson, geometric, uniform, normal, exponential, Weibull, and gamma distributions to the real world problems	Apply
CO4	Apply joint probability distributions to find marginal and conditional distributions and also transformation of two random variables	Apply
CO5	Apply the concepts of random variables and distributions for the central limit theorem.	Apply
CO6	Apply the concept of reliability for system of independent Components and expected system lifetime.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1.	L	L	L	M	L	-	-	-	-	-	-	-	L	M
CO2.	S	S	M	M	L	-	-	-	-	-	-	-	L	S
CO3	S	S	M	M	L	-	-	-	-	-	-	-	L	S
CO4	S	S	M	S	-	-	-	-	-	-	-	-	L	S
CO5	S	S	M	S	-	-	-	-	-	-	-	-	L	S
CO6	S	S	L	L	-	-	-	-	-	-	-	-	L	S

s- Strong; M-Medium; L-Low

Assessment Pattern

CO	CAT1						Assignment 1						CAT2						Assignment2						Terminal					
Bloom's level	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
CO1	4	10	20						30																2	5	8			
CO2	4	10	20						35																2	5	10			
CO3	2	10	20						35																	5	16			
CO4													4	10	30						35				2	5	16			
CO5													2	10	20						35				2		12			
CO6													4		20						30				2		8			
Total (in %)	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.

Reference Books and Web Resources

1. Sheldon M. Ross, "Introduction to Probability Models", Academic Press, 12th edition 2019.
2. Saeed Ghahramani, "Fundamentals of Probability with Stochastic Processes", Pearson Education, 4th edition 2019.
3. Jay L Devore, "Probability and Statistics for Engineering and Sciences", Cengage Learning, 2015.
4. K. S. Trivedi, "Probability and Statistics with Queuing, Reliability and Computer Science Applications", John Wiley &Sons, 2016.
5. https://www.khanacademy.org/math/statistics-probability
6. https://www.probabilitycourse.com/
7. https://mathworld.wolfram.com/topics/ProbabilityandStatistics.html

Course Contents and Lecture Schedule

Module No.	Topic	No. of Periods
1	Probability Basic Concepts:	
1.1	Introduction and Sample space and events	1
1.2	Axiomatic approach to probability – Basic theorems.	1
1.3	Conditional Probability	1
1.4	Law of multiplication	1
1.5	Law of total probability and Bayes Theorem	1
1.6	Independence	2
2	Random Variables:	

Module No.	Topic	No. of Periods
2.1	Discrete random variables	1
2.2	Continuous random variables	1
2.3	probability mass function and density function	2
2.4	distribution function	1
2.5	Expectation and variance	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	1
4.2	Marginal and conditional distributions	2
4.3	Statistical independence	1
4.4	Conditional expectation	1
4.5	Transformation of two random variables.	2
5	Central Limit Theorems:	
5.1	Moments and moment generating functions	2
5.2	Sums of independent random variables	1
5.3	Limit theorems: Markov and Chebyshev inequalities	2
5.4	Law of Large numbers	1
5.5	Central Limit Theorem.	1
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	44

Course Designer(s):

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Dept. of Applied Mathematics and Computational Science.

		Category	L	T	P	Credit
23DS220	**APPLIED STATISTICS**	PCC	4	0	0	4

Preamble

The students will be able to learn the data analysis with the basics of graphs and tables, Test the hypothesis on mean, variance, proportion of small and large samples, for goodness of fit and independence of attributes and apply the concept of correlation, linear and nonlinear regressions to Data Science problems.

Prerequisite

Nil

Course Outcomes

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

CO1	Learn the basic concepts of distributions, charts and various types of measures.	Understand
CO2	Apply the concepts of estimation and its type in mean, proportion and variance.	Apply
CO3	Demonstrate the concept of testing of hypothesis for small and large samples by using various tests like t-test, F-test, z-test and chi-square test	Apply
CO4	Apply the concept of Correlation and regressions to engineering problems Apply least square method in fitting linear and nonlinear regression curves.	Apply
CO5	Apply Multiple regression and correlation analysis, Inferences about population parameters and Modeling techniques.	Apply
CO6	Apply the concepts of Analysis of variance in real life problems	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	L	L	L	-	-	-	-	-	-	-	-	S	S
CO2	S	M	M	M	-	-	-	S	-	-	-	-	S	S
CO3	S	M	M	M	-	-	-	-	S	-	-	-	S	S
CO4	S	M	M	M	-	-	-	-	-	-	-	M	S	S
CO5	S	M	M	M	-	-	-	-	-	-	-	-	S	S
CO6	S	M	L	M	-	-	-	-	-	-	-	-	S	S

S- Strong; M-Medium; L-Low

Assessment Pattern

CO	CAT1						Assignment 1						CAT2						Assignment2						Terminal					
Bloom's level	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
CO1	5	10																							2	5				
CO2	5	10	30						50																2	5	10			
CO3		10	30						50																2		20			
CO4													5	10	20						50				2	5	10			
CO5													5	10	20						25				2	5	10			
CO6														10	20						25					10	10			
Total (in %)	100						100						100						100						100					

Syllabus

DESCRIPTIVE STATISTICS: Frequency distribution – Bar graphs and Pie charts – Histogram- Ogive — Simpson's paradox — Measures of Location — Measures of Variability – Measures of distribution shape, relative location and detecting outliers – Exploratory Data analysis, Stem-and-leaf display – Measures of Association between two variables.

STATISTICAL INFERENCE: Sampling distribution - Estimation: Point estimation, interval estimation - Criteria of a good estimator — Interval estimation of mean, proportion, and variance (single sample and two samples).

HYPOTHESIS TESTING: General concepts - Errors in Hypothesis testing - One-and two-tailed tests - Tests concerning mean, proportion, and variance - Tests for Goodness of fit and independence of attributes.

CORRELATION AND REGRESSION: introduction - Estimation using the regression line - Correlation analysis -Limitations, errors, and caveats of using regression and correlation Analyzes - Multiple regression and correlation analysis - Inferences about population parameters — Modeling techniques.

ANALYSIS OF VARIANCE: Introduction to design of experiments, Analysis of variance.

TOOLS: d3.js, Excel, Tableau.

Reference Books

1. Richard I. Levin. David S. Rubin, "Statistics for Management", Pearson Education, 2017.
2. Ronald E. Walpole, Raymond H. Meyers and Sharon L. Meyers, "Probability andStatistics for Engineers and Scientists", Pearson Education, 2019.
3. L. Devore, "Probability and Statistics for Engineering and Sciences", Cengage Learning, 2018.
4. Anderson, Sweeney and Williams , "Statistics for business and economics", CengageLearning, 2014.
5. Saeed Ghahramani, "Fundamentals of Probability with Stochastic Processes", Pearson Education, 2018.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Periods
1	**DESCRIPTIVE STATISTICS:**	
1.1	Frequency distribution	2
1.2	Bar graphs and Pie charts	1
1.3	Histogram- Ogive – Simpson's paradox	2
1.4	Measures of Location – Measures of Variability	2
1.5	Measures of distribution shape, relative location and detecting outliers	2
1.6	Exploratory Data analysis, Stem-and-leaf display	2

1.7	Measures of Association between two variables	2
2	**STATISTICAL INFERENCE**:	
2.1	Sampling distribution - Estimation:	2
2.2	Point estimation, interval estimation	2
2.3	Criteria of a good estimator – Interval estimation of mean, proportion, and variance (single sample and two samples)	2
2.4	Maximum likelihood estimator	2
2.5	Hypothesis Testing: General concepts - Errors in Hypothesis testing	2
2.6	One-and two-tailed tests	2
2.7	Tests for Goodness of fit and independence of attributes	1
3	**CORRELATION AND REGRESSION:**	
3.1	Introduction - Estimation using the regression line	2
3.2	Correlation analysis -Limitations	2
3.3	Errors, and caveats of using regression and correlation	2
3.4	Multiple regression and correlation analysis	2
3.5	Inferences about population parameters	2
3.6	Modelling techniques	2
4	**ANALYSIS OF VARIANCE:**	1
4.1	Introduction to design of experiments,	2
4.2	Analysis of variance	1
4.3	Completely Randomized Design and Randomized Block Design.	1
5.0	Tools: d3.js, Excel, Tableau.	2
	Total	**45**

Course Designers:

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		Category	L	T	P	Credits
23DS230	**GRAPH THEORY**	FC	4	0	0	4

Preamble

This course will enable students to learn some basic types of graphs, connectivity and the complexity of the model and create the model to real time problem through graphs. It also enables to learn the random graphs and Ramsey numbers to apply in the social networks.

Prerequisite

- Nil

Course Outcomes

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

CO1	Explain the basic concepts of Graphs, walk, path, circuits and apply the concepts of Eulerian, Hamiltonian graphs in real life problems.	Apply
CO2	Explain the concepts of digraphs and relate the application of graph theory to computer science field.	Apply
CO3	Apply the concepts of trees and connectivity for network problems.	Apply
CO4	Apply the concepts of planarity and duality for solving geometric problems.	Apply
CO5	Use the matrix representation and solve minimum path finding problem.	Apply
CO6	Apply the concepts of Colouring, Covering and Domination for solving real time problems.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S	S	S	-	-	L	-	-	-	-	-	L	M
CO2	S	S	S	S	-	-	-	-	-	-	-	-	L	S
CO3	M	M	S	S	-	-	-	-	-	-	-	-	L	S
CO4	S	S	S	S	-	-	M	-	-	-	-	-	L	S
CO5	S	S	S	S	-	-	M	-	-	-	-	-	L	S
CO6	M	S	S	S	-	-	M	-	-	-	-	-	S	S

S- Strong; M-Medium; L-Low

Assessment Pattern

CO	CAT1						Assignment 1						CAT2						Assignment2						Terminal					
Bloom's level	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**
CO1	4	10	20						30																4	5	10			
CO2	2	10	20						40																2	-	20			
CO3	4	10	20						30																2	5	10			
CO4													4	10	20						30				2	-	10			
CO5													2	10	20						40				-	5	10			
CO6													4	10	20						30				-	5	10			
Total (in %)	100						100						100						100						100					

Syllabus

INTRODUCTION: Graphs and its Applications, Finite and Infinite Graphs, Incidence and Degree, Isolated Vertex, Pendent 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.

DIRECTED GRAPHS: Digraphs and Binary Relations Directed Paths and Connectedness, Euler Digraphs, Trees with Directed Edges, Acyclic Digraphs and Decyclization.

TREES AND FUNDAMENTAL CIRCUITS: Trees and its Properties, Distance and Canters, Rooted and Binary Trees, Spanning Trees. **Cut-Sets and Cut-Vertices:** Properties, Connectivity and Separability, Network Flows, 1-Isomorphism, 2-Isomorphism.

PLANAR AND DUAL GRAPHS: Planar Graphs, Kuratowski's Two Graphs, Combinatorial and Geometric Graphs and its Dual.

MATRIX REPRESENTATION OF GRAPHS: Incidence Matrix, Matrix - Path, Adjacency, Cut-Set, Application to a Switching Network.

COLORING, COVERING AND PARTITIONING: Chromatic Number, Partitioning, Polynomial, Matching, Coverings, Four Colour Problem.

Reference Books and Web Resources:

1. Narsingh Deo, "Graph Theory with Applications to Engineering and Computer Science", 2016.
2. Douglas B. West, "Graph Theory", Pearson Education, 2015.
3. Bondy J.A. and Murty U.S.R, "Graph Theory", Springer, 2013.
4. Balakrishnan R and Ranganathan K, "A Textbook of Graph Theory", Springer-Verlag, 2012.
5. https://www.graphclasses.org/index.html
6. https://t5k.org/graph/

Course Contents and Lecture Schedule

Module No.	Topic	No. of Periods
1	**Introduction**	
1.1	Basic Definitions of graphs with examples	3
1.2	Paths and Circuits concepts with example	3
1.3	Classify the Eulerian and Hamiltonian graphs	3
2	**DIRECTED GRAPHS**	
2.1	Digraphs and Binary Relations	2
2.2	Directed Paths and Connectedness	2
2.3	Trees with Directed Edges, Acyclic Digraphs and Decyclization.	3
3	**TREES & CONNECTIVITY**	

Module No.	Topic	No. of Periods
3.1	Trees and its Properties	2
3.2	Concepts of Rooted, Binary Trees and Spanning Trees	2
3.3	Concepts of Connectivity and Separability	2
3.4	Explanation of Network Flows, 1-Isomorphism, 2-Isomorphism	2
4	**PLANARITY & DUALITY**	
4.1	Concepts of Planar Graphs and its applications.	2
4.2	Kuratowski's algorithm of two Graphs	2
4.3	Classify the Geometric Graphs and it's Dual	2
5	**MATRIX REPRESENTATION**	
5.1	Incidence Matrix, Matrix - Path	2
5.2	Adjacency & Cut-set	2
5.3	Application to a Switching Network	2
6	**COLORING, COVERING AND PARTITIONING**	
6.1	Concepts of Coloring.	2
6.2	Chromatic Number, Four colour theorem.	2
6.3	Matchings & Coverings and its applications.	2
6.4	Partitioning & Polynomial of graphs.	2
	Total	44

Course Designer(s):

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23DS240 OBJECT ORIENTED PROGRAMMING

Category	L	T	P	Credit
PCC	4	0	0	4

Preamble

To provide sound knowledge on basic and advanced concepts of Object-Oriented programming and apply them in developing industrial strength software applications.

Prerequisite

- 23DS140 Problem Solving Using C programming.

Course Outcomes

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

CO1	Explain the differences between structural and object oriented programming	Understand
CO2	Identify classes, relevant data representations, operations and interactions for the entities in a given problem description.	Apply
CO3	Develop object-oriented programs by applying Abstraction, Encapsulation and Information hiding.	Apply
CO4	Practice code reusability and extensibility by means of Inheritance and Polymorphism.	Apply
CO5	Illustrate the use of templates and template libraries for a given user requirement	Apply
CO6	Write C++ programs with I/O streams and file objects for a given user requirement	Apply
CO7	Select suitable object-oriented programming constructs for developing real time applications.	Analyze

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1.	S	M	S	-	L	-	-	-	-	-	-	-	M	L
CO2.	S	S	S	L	L	-	-	-	-	-	-	-	S	M
CO3	S	S	S	M	M	L	-	-	L	-	-	-	S	M
CO4	S	S	S	M	M	L	-	L	M	-	L	-	S	M
CO5	S	S	S	M	M	-	-	-	-	-	-	-	S	M
CO6	S	S	S	M	M	-	-	L	-	-	-	-	S	M
CO7	S	S	S	M	M	L	-	L	M	-	M	L	S	M

S- Strong; M-Medium; L-Low

Assessment Pattern

CO	CAT1						Assignment 1						CAT2						Assignment2						Terminal					
Bloom's level	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
CO1	5	10																							4	5				
CO2	5	10	20																						4		10			
CO3		10	20						50																4	5	10			
CO4			20						50																4	5	10			
CO5													5	10	20						25				2		10			
CO6													5	10	20						25				2	5	10			
CO7														10		20						50						10		
Total (in %)	100						100						100						100						100					

Syllabus

Principles of Object Oriented Programming: Software crisis Software Evolution - Procedure Oriented Programming - Object Oriented Programming Paradigm - Basic Concepts and Benefits of OOP - Object Oriented Programming Language - Application of OOP.

Structure of C++: Tokens, Expressions and Control Structures - Operators in C++ - Manipulators.

Functions in C++: Function Prototyping - Call by Reference - Return by reference - Inline functions - Default, Const Arguments - Function Overloading

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 - Friend Functions - Returning Objects - Const Member functions - Pointers to Members – Virtual functions.

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

Operator Overloading: Overloading Unary and Binary Operators - Overloading Binary Operators using Friend functions – Operator Type conversion.

Inheritance: Defining Derived Classes - Single Inheritance - Making a Private Member Inheritable - Multiple Inheritance - 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.

Templates & Exception Handling: Introduction to Templates, Generic Functions and Generic Classes – Exception Handling – STL Components.

Streams: String I/O - Character I/O - Object I/O - I/O with multiple Objects - File pointers - Disk I/O with member functions.

Reference Books

1. Bjarne Stroustrup, “The C++ Programming Language”, Pearson Education, 2013.
2. Yashavant P. Kanetkar, “Let Us C++”, BPB Publications, 2020.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Periods
1	**Principles of Object Oriented Programming**	
1.1	Software crisis Software Evolution - Procedure Oriented Programming - Object Oriented Programming Paradigm	2
1.2	Basic Concepts and Benefits of OOP -Object Oriented Programming Language	2
1.3	Application of OOP	1
2	**Structure of C++**	

Module No.	Topic	No. of Periods
2.1	Tokens, Expressions and Control Structures	1
2.2	Operators in C++ - Manipulators	1
3	**Functions in C++**	
3.1	Function Prototyping - Call by Reference - Return by reference	1
3.2	Inline functions - Default, Const Arguments	1
3.3	Function Overloading.	1
4	**Classes and Objects**	
4.1	Member functions - Nesting of Member functions - Private member functions	2
4.2	Memory allocation for Objects - Static data members - Static Member Functions	2
4.3	Arrays of Objects - Objects as Function Arguments - Friend Functions	1
4.4	Returning Objects - Const Member functions - Pointers to Members- virtual functions.	1
5	**Constructors**	
5.1	Parameterized Constructors - Multiple Constructors in a Class	1
5.2	Constructors with Default Arguments - Dynamic Initialization of Objects	2
5.3	Copy and Dynamic Constructors – Destructors overloading.	2
6	**Operator Overloading**	
6.1	Overloading Unary and Binary Operators	1
6.2	Overloading Binary Operators using Friend functions	2
6.3	Operator Type conversion	1
7	**Inheritance**	
7.1	Defining Derived Classes - Single Inheritance - Making a Private Member Inheritable	2
7.2	Multiple Inheritance - Hierarchical Inheritance - Hybrid Inheritance	1
7.3	Virtual Base Classes - Abstract Classes - Constructors in Derived Classes	1
7.4	Member Classes - Nesting of Classes – Composition – Aggregation	2
8	**Polymorphism**	
8.1	Basics of polymorphism – Types of polymorphism	2

Module No.	Topic	No. of Periods
8.2	Compile and Run Time Polymorphism - Virtual function	1
8.3	Object Slicing – Virtual Destructor – Dynamic binding	2
9	**Templates & Exception Handling**	
9.1	Introduction to Templates, Generic Functions and Generic Classes	2
9.2	Exception Handling – STL components.	2
10	**Streams**	
10.1	String I/O -Character I/O - Object I/O	1
10.2	I/O with multiple Objects - File pointers	2
10.3	Disk I/O with member functions.	1
	Total	**44**

Course Designer(s)

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23DS250	ORGANIZATIONAL THEORY AND BEHAVIOUR	Category	L	T	P	Credit
		PCC	3	0	0	3

Preamble

To learn challenges and opportunities in organizations from a behavioral science perspective.

Prerequisite

Nil

Course Outcomes

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

CO1	Develop an Organisational Behaviour model for any type of Organization.	Apply
CO2	Develop Managerial skills for Individual Behaviours.	Apply
CO3	Develop the quality of Leadership.	Apply
CO4	Analyze the Common biases and eradication in Decision Making Process.	Analyze
CO5	Adapt to the organizational culture.	Apply
CO6	Analyze how to manage the Stress during a job.	Analyze

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M	-	-	-	-	-	-	-	-	-	-	L	-
CO2	S	M	-	-	-	-	-	-	S	-	-	-	L	-
CO3			-	-	-	-	-	-	-	-	M	-	L	-
CO4	S		M	-	-	-	-	M	-	-	S	-	-	L
CO5	S	S	M	-	-	-	-	-	-	-	-	-	-	L
CO6	S	S	L	-	-	-	-	-	-	-	-	-	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern

CO	CAT1						Assignment 1						CAT2						Assignment2						Terminal					
Bloom's level	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
CO1	5	10	20						50																2	5				
CO2	5	10	20						25																2	5	10			
CO3		10	20						25																2	5	10			
CO4														10	10	20						30			2	5		20		
CO5													5	10	15						40				2	5	10			
CO6													5	10		15						30				5		10		
Total (in %)	100						100						100						100						100					

Syllabus

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.

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

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.

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

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

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

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.

Reference Books

1. Stephen P. Robbins, “Organisational Behaviour”, 11/e, Pearson, 17th Edition 2022 (Chapters 1,3,5, 6, 10,11,12, 16,17)
2. Uma Sekaran, “Organisational Behaviour”, 2/e, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2010.
3. Sharma, R.A, “Organisational Theory and Behaviour”, 2/e, Tata McGraw-Hill Ltd., New Delhi, 2012.

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	1
1.6	Ability - Learning. Values, Attitudes and Types of Attitudes	1
	Job satisfaction	
1.7	Measuring Job satisfaction.	1

1.8	Effect of Job satisfaction on employee performance.	1
2	**Personality and Values**	
2.1	Personality – Personality determinants	1
2.2	Achieving personality fit	1
2.3	Factors Influencing perception	1
2.4	Attribution Theory	1
	Perception / Individual Decision Making	
2.5	Ethics in Decision Making. Motivation	1
2.6	Management by Objectives	1
3	**Understanding work teams**	
3.1	Teams Vs Groups – Types of Teams	1
3.2	Creating Effective Teams – Turning Individuals into Team Players	1
	Communication	
3.3	Functions of Communication	1
3.4	Communication Process – Direction of communication	1
3.5	Interpersonal and Organizational communication	1
4	**Leadership**	1
4.1	Leadership – Meaning	2
4.2	Trait Theories – Behavioral Theories	1
4.3	Contingency Theories	2
4.4	Contemporary issues in Leadership	2
5	**Organizational culture**	1
5.1	Organizational culture: Meaning – Creating and sustaining culture	1
5.2	How employees learn culture	1
5.3	creating an ethical organizational culture	1
5.4	creating a customer responsive culture	1
5.6	Approaches to Managing organizational change	1
5.7	Creating a Culture	1
5.8	Change in Business	1
5.9	Work stress and its Management	1
	Total	**36**

Course Designers:

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23DS270	PYTHON PROGRAMMING AND APPLIED STATISTICS LAB	Category	L	T	P	Credit
		PCC	0	0	6	3

Preamble

The purpose of this course is to introduce students to the field of programming using Python for statistically displaying and describing data, including the normal curve, regression, probability, statistical inference, confidence intervals, and hypothesis tests, with applications in the real world.

Prerequisite

Nil

Course Outcomes

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

CO1	Make use of branching, looping, strings, and function concepts to develop Python programmes for the given problem.	Apply
CO2	Implement object-oriented programming concepts and file handling in Python.	Apply
CO3	Design a basic data structure using Python programming constructs and its packages.	Apply
CO4	Interpret the usage of packages and libraries in Python programming for exploratory data analysis and data cleaning.	Apply
CO5	Perform the regression-correlation and statistical inference analyses.	Apply
CO6	Perform hypothesis testing (z test, t test, F test, and chi squared test).	Apply

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1.	S	M	S	L	L	-	-	-	-	-	-	-	S	M
CO2.	S	S	S	L	L	-	-	-	-	-	L	-	S	M
CO3	S	S	S	L	L	-	-	-	L	-	L	-	S	M
CO4	S	S	S	M	M	L	-	L	M	-	L	L	S	S
CO5	S	S	S	M	M	L	-	L	M	-	-	-	S	S
CO6	S	S	S	M	M	L	-	L	M	-	M	L	S	S

S- Strong; M-Medium; L-Low

List of Experiments

Develop Python Programs for

1. Basic looping and branching programs.
2. Programs on Dictionary, tuples and Nested Lists.
3. User defined functions.
4. String programs.
5. Classes and Objects.
6. File handling with exceptions.
7. Basic Data structures design using python.

Solve the Statistical Problems using Python:

1. Exploratory Data Analysis and Data Cleaning- Pre-defined libraries & packages.
2. Perform calculations that measure the central tendency – Mean, Median, Mode and dispersion of data – Percentile, Range, Standard Deviation.
3. Visualizing Dispersion & Frequency (Boxplot, Histogram, Bar chart, Pie chart, Line charts, etc.)
4. Implementation of measures of Skewness, moments and kurtosis.
5. Determination of point and interval estimates.
6. Calculate and interpret the correlation coefficient of the two variables. (pearson, Spearman)
7. Perform paired t test, F test and Chi square test.
8. Hypothesis testing & ANOVA.
9. Solve linear regression line using python for the problem.

Reference Books

1. John V.Guttag, “Introduction to Computation and Programming Using Python : With Application to Understanding Data”, Prentice-Hall International publishers, Second Edition, 2017.
2. Yashavant Kanetkar, Aditya Kanetkar, “Let us Python, BPB publication, 1st Edition, 2019.
3. I. Levin Richard, H. Siddiqui Masood, S. Rubin David, Rastogi Sanjay, “Statistics for Management”, Pearson Education, 2017.
4. Ronald E. Walpole, Raymond H. Meyers and Sharon L. Meyers, “Probability and Statistics for Engineers and Scientists”, Pearson Education, 2014.

Course Designer(s)

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23DS280	OBJECT ORIENTED PROGRAMMING LAB	Category	L	T	P	Credit
		PCC	0	0	4	2

Preamble

This course is intended for the students to learn Object Oriented Programming and the design of computer solutions with the programming principles. The course emphasizes on practicing OOP concepts, Functions, Polymorphism, Inheritance and I/O and enables them to apply Object Oriented Programming approach to programming.

Prerequisite

- 23DS170: C Programming LAB

Course Outcomes

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

CO1	Illustrate the basic concepts of objected oriented programming for building object based applications	Apply
CO2	Develop programs using object-oriented concepts like abstraction, encapsulation, polymorphism and inheritance to solve the given problem.	Apply
CO3	Demonstrate overloading of methods and operators with appropriate object-oriented programming constructs for different user specifications with suitable programs	Apply
CO4	Implement templates with standard template libraries and create user defined templates.	Apply
CO5	Develop programs for creating packages and handle exceptions for any real-time requirements	Apply
CO6	Create object-oriented programs to demonstrate file handling	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:	S	M	L	-	L	L	-	-	-	-	-	-	M	M
CO2:	S	M	L	-	L	L	-	-	-	-	-	-	M	M
CO3:	S	M	L	-	L	L	-	-	-	-	-	-	M	M
CO4:	S	M	L	-	L	L	-	-	-	-	-	-	M	M
CO5:	S	M	L	-	L	M	-	-	-	-	-	-	M	M
CO6:	S	M	L	-	L	M	-	-	-	-	-	-	M	M

S- Strong; M-Medium; L-Low

List of Experiments

Develop programs in C++ for different user specification using the below constructs in the context of classes and objects:

1. Implementation of classes and objects
2. Static member data and methods
3. Objects as Function Arguments and return types
4. Constructor types and its overloading
5. Method Overloading and method overriding with base class and derived class
6. Operator Overloading: Unary and Binary using member function & non-member Function.
7. Aggregation, composition and inheritance
8. Friend Function and Friend Class
9. Use of pointers within classes (this pointer, call and return of objects)
10. Abstract class, Virtual function and creating packages
11. Exception handling
12. File handling
13. Templates and STL Components

Mini project

Reference Books

1. H.M. Deitel and P.J. Deitel, C “How to program Introducing C++ and Java”, Fourth Edition, Pearson Prentice Hall, (2012), Reprint 2020.
2. Yashavant P. Kanetkar, “Let Us C++”, BPB Publications, 2020.

Course Designer(s):

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23DS310	PARTIAL DIFFERENTIAL EQUATIONS AND TRANSFORMS	Category	L	T	P	Credit
		FC	4	0	0	4

Preamble

This course will enable students to mathematically formulate practical problems in terms of partial differential equations, solve them and physically interpret the results using transformations.

Prerequisite

Nil

Course Outcomes

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

CO1	Apply the concept of PDE for certain practical problems to solve them and physically interpret the results.	Apply
CO2	Apply Z transform technique to find the inverse Z transforms to solve the given ordinary differential equation and modelling.	Apply
CO3	Apply Laplace transform technique to find the inverse Laplace, solve the given ordinary differential equation and integral equations.	Apply
CO4	Express the periodic functions arising in the study of engineering problems as Fourier series of Sines and Cosines.	Apply
CO5	Obtain the Fourier series expansion in engineering problems using half range sine and cosine series.	Apply
CO6	Solve some of the well-known integral transforms (like Fourier, Fourier Sine and Cosine) and properties. Also Apply the Fourier concepts in solving Discrete and Fast Fourier transforms.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	S	S	S	M	L	L	-	-	-	-	M	L	S
CO2	M	S	M	S	L	L	L	-	-	-	-	L	L	S
CO3	S	S	M	S	M	L	L	-	-	-	-	M	L	S
CO4	M	S	M	S	L	L	L	-	-	-	-	M	L	S
CO5	S	S	M	S	L	L	L	-	-	-	-	M	L	S
CO6	S	S	M	S	L	L	L	-	-	-	-	M	L	S

S- Strong; M-Medium; L-Low

Assessment Pattern

CO	CAT1						Assignment 1						CAT2						Assignment2						Terminal					
Bloom's level	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
CO1	4	10	20						30																2	5	10			
CO2	2	10	20						40																2	5	10			
CO3	4	-	30						30																2	-	20			
CO4													4	10	20						30				-	5	10			
CO5													2	10	20						30				2	5	10			
CO6													4	-	30						40				2	-	10			
Total (in %)	100						100						100						100						100					

Syllabus

PARTIAL DIFFERENTIAL EQUATIONS: Formation of partial differential equations by elimination of arbitrary constants and functions – Solution of standard types of first order PDE – Lagrange's linear equation – Linear PDE of second and higher order with constant coefficients.

Z-TRANSFORM: Z - transform of standard functions - Properties - Inverse Z-transform — Convolution Theorem – Introduction to Difference operators - Formation and Solution of difference equations.

LAPLACE TRANSFORM: Transforms of Standard Functions - Transforms of derivatives and integrals - Transform of Unit step function and Dirac's delta function – Transforms of Periodic functions - Inverse Laplace transform - Partial Fraction - Convolution Theorem - Method of solving ordinary linear differential equations with constant coefficient and solving integral equations.

FOURIER SERIES: Dirichlet's conditions, statement of Fourier theorem, Fourier coefficients, Even and odd functions, change of scale, Half-range sine and cosine series, RMS value, Parseval's theorem.

FOURIER TRANSFORM: Fourier integrals - Fourier transform - Fourier sine and cosine transform - Transforms of standard functions - Properties, Convolution theorem – Discrete Fourier and Fast Fourier Transforms – Computation of inverse DFT - Properties of DFT.

Reference Books and web resources

1. Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley & Sons, 10th edition 2014.
2. Ray Wylie C, Louis C Barret," Advanced Engineering Mathematics", McGraw Hill, 2013.
3. Roland E. Thomas and Albert J. Rosa, "The Design and Analysis of Linear Circuits", John Wiley & Sons, 2016.
4. Michael D. Greenberg, "Advanced Engineering Mathematics", Pearson Education, 2014.
5. https://www.khanacademy.org/math/differential-equations/laplace-transform
6. https://tutorial.math.lamar.edu/Classes/DE/DE.aspx

Course Contents and Lecture Schedule

Module No.	Topic	No. of Periods
1	**PARTIAL DIFFERENTIAL EQUATIONS**	
1.1	Formation of partial differential equations by elimination of arbitrary constants and functions.	2
1.2	Solution of standard types of first order PDE.	2
1.3	Lagrange's linear equation – Linear PDE of second and higher order with constant coefficients.	2
2	**Z-Transform**	
2.1	Z - transform of standard functions	2
2.2	Properties of Z-transform	2
2.3	Inverse Z-transform & Convolution Theorem	2
2.4	Introduction to difference operator	1
2.5	Formation and Solution of difference equations.	2
3	**Laplace Transform**	
3.1	Transforms of Standard Functions, Transforms of derivatives and integrals	2

Module No.	Topic	No. of Periods
3.2	Transform of Unit step function and Dirac's delta function - Transforms of Periodic functions	2
3.3	Inverse Laplace transform, Partial Fraction, Convolution Theorem	2
3.4	Method of solving ordinary linear differential equations with constant coefficient and solving integral equations.	2
4	**Fourier Series**	
4.1	Dirichlet's conditions, statement of Fourier theorem	3
4.2	Fourier coefficients, Even and odd functions	2
4.3	change of scale	2
4.4	Half-range sine and cosine series	2
4.5	RMS value, Parseval's theorem	2
5	**Fourier Transform**	
5.1	Fourier integrals - Fourier transform	2
5.2	Fourier sine and cosine transform	2
5.3	Transforms of standard functions - Properties, Convolution theorem	2
5.4	Discrete Fourier and Fast Fourier Transforms	2
5.5	Computation of inverse DFT, properties of DFT	2
	Total	**44**

Course Designer(s):

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23DS320 ABSTRACT ALGEBRA

Category	L	T	P	Credit
FC	4	0	0	4

Preamble

This course will enable students to learn the basic concepts of algebraic structures and groups, apply the concepts of normal subgroups and Cayley's theorem, model the concepts of Coding of Binary information and Error detection and learn the concepts of rings, fields and unique factorization theorem

Prerequisite

Nil

Course Outcomes

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

CO1	Apply the concepts of Groups, subgroups and its properties with Permutation.	Apply
CO2	Apply the concept of groups to learn about normal subgroups and fundamental theorem of group homomorphism	Apply
CO3	Apply the concept of groups to learn about coding of binary information, decoding, error correction and residue arithmetic	Apply
CO4	Apply the concepts of Rings to Learn its properties and different types of rings.	Apply
CO5	Apply the concept of rings to find factorization of polynomials and primitive polynomials	Apply
CO6	Apply the concept of fields to find the structure of finite field and GF	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L	L	L	M	-	-	-	-	-	-	-	-	L	M
CO2	S	S	M	M	-	-	-	-	-	-	-	-	L	S
CO3	S	S	M	M	-	-	-	-	-	-	-	-	L	S
CO4	S	S	M	S	-	-	-	-	-	-	-	-	L	S
CO5	S	S	M	S	-	-	-	-	-	-	-	-	L	S
CO6	S	S	L	L	-	-	-	-	-	-	-	-	L	S

S- Strong; M-Medium; L-Low

Assessment Pattern

CO	CAT1						Assignment 1						CAT2						Assignment2						Terminal					
Bloom's level	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
CO1	4	10	20						30																2	5	8			
CO2	4	10	30						35																2	5	16			
CO3	2	10	10						35																2		8			
CO4													4	10	30						35				2	5	14			
CO5													2	10	20						35				2	5	14			
CO6													4		20						30						10			
Total (in %)	100						100						100						100						100					

Syllabus

GROUPS:
Groups - Definition and Example, Properties of Groups, Permutation Groups, Symmetric Groups, Subgroups, Cyclic Groups, Cosets and Lagrange's theorem, Normal subgroups, Isomorphism, Homomorphism, Automorphism, Cayley's theorem, Factor group, Fundamental theorem of group homomorphism.

CODING THEORY AND RESIDUE ARITHMETIC:
Coding of Binary information and Error detection – Group codes – Decoding and Error correction, Overview of Residue arithmetic.

RINGS:
Definition and Properties – Subrings, Ring of Quaternions, Homomorphism, Ideals and Quotient Rings, Integral domain, Euclidean ring - Unique factorization theorem, Polynomials Rings – Properties, Division Algorithm, Factorization of Polynomials – Primitive polynomials.

FIELDS:
Definition – Subfields - Finite fields – Galois Field.

Reference Books and web resources

1. Joseph A. Gallian, "Contemporary Abstract Algebra", Brooks/Cole, 9th edition 2018.
2. Herstein I. N., "Topics in Algebra", John Wiley & Sons, 2012.
3. Tremblay J. P. and Manohar R., "Discrete Mathematical Structures with Applications to Computer Science", Tata McGrawHill, 2017.
4. Ralph P. Grimaldi and Ramana B. V., "Discrete and Combinatorial Mathematics: An Applied Introduction", Pearson Education, 5th edition 2019.
5. https://mathworld.wolfram.com/AbstractAlgebra.html

Course Contents and Lecture Schedule

Module No.	Topic	No. of Periods
1	Groups	
1.1	Groups - Definition and Example	1
1.2	Properties of Groups	1
1.3	Permutation Groups, Symmetric Groups	2
1.4	Subgroups	2
1.5	Cyclic Groups	2
1.6	Cosets and Lagrange's theorem	2
1.7	Normal subgroups	1
1.8	Isomorphism	2
1.9	Homomorphism, Automorphism, Cayley's theorem	2
1.10	Factor group – Fundamental theorem of group	2

Module No.	Topic	No. of Periods
	homomorphism	
2	CODING THEORY AND RESIDUE ARITHMETIC:	
2.1	Coding of Binary information and Error detection	2
2.2	Group codes	2
2.3	Decoding and Error correction	2
2.4	Overview of residue arithmetic	3
3	RINGS:	
3.1	Definition and Properties	1
3.2	Subrings, Ring of Quaternions	2
3.3	Homomorphism, Ideals and Quotient Rings	2
3.4	Integral domain, Euclidean ring	2
3.5	Unique factorization theorem, Polynomials Rings – Properties	2
3.6	Division Algorithm, Factorization of Polynomials – Primitive polynomials	**2**
4	FIELDS:	
4.1	Definition	1
4.2	Subfields	2
4.3	Finite fields	2
4.4	Galois Field	2
	Total	**44**

Course Designer(s):

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23DS330 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 enables the students to identify appropriate data structures and design suitable algorithms for real world user requirements.

Prerequisite

- 23DS140 Problem Solving Using C programming

Course Outcomes

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

CO1	Explain the organization and operations of different data structures with an understanding of their efficiency	Understand
CO2	Demonstrate the operations of linear data structures (Array, Linked list, stack and queues)	Apply
CO3	Demonstrate the operations of non-linear data structures (Trees, Graph)	Apply
CO4	Demonstrate search and sort algorithms with an understanding of their analysis	Apply
CO5	Implement the user requirements by selecting appropriate linear and non-linear data structures	Apply
CO6	Modify the existing operations of data structures for changing needs of the software requirements	Analyze

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	L	L	L	M	-	-	-	L	L	-	L	M	L
CO2	S	M	M	L	M	-	-	-	L	L	-	L	M	M
CO3	S	M	M	L	M	-	-	-	L	L	-	L	M	M
CO4	S	M	M	L	M	-	-	-	L	L	-	L	M	M
CO5	S	M	S	L	M	-	-	-	L	L	-	L	S	S
CO6	S	S	S	L	M	-	-	-	L	L	-	L	S	S

S- Strong; M-Medium; L-Low

Assessment Pattern

CO	CAT1						Assignment 1						CAT2						Assignment2						Terminal					
Bloom's level	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
CO1	5	20																							2	10				
CO2	5		30						50																2	5	10			
CO3													5	20	20						25				2	5	10			
CO4		5	10										5	10											2	5	10			
CO5		5	20						50						20						25				2	5	15			
CO6																20						50						15		
Total (in %)	100						100						100						100						100					

Syllabus

Introduction: Abstraction - Data structures - Abstract Data Types - Primitive data structures – Types of data structures- Analysis of algorithms - Best, worst and average case time complexities - notations.

Arrays and Linked Lists: Data storage and primitive Operations –Singly linked lists, Doubly linked lists, Circular lists - Applications: Addition of Polynomials; Sparse Matrix representation

Stacks: Primitive operations - Sequential implementation – Linked Stacks. Applications - Recursion – Expression Processing

Queues: Primitive operations - sequential implementation - Dequeues – Applications - Linked queues - Dynamic Storage Management.

Trees: Terminologies - Implementation - BINARY TREE: Properties - Sequential and linked representation –Traversals - Expression trees - Infix, Postfix and Prefix expressions - Binary Search Tree -Insertion and deletion – other operations - Need for balancing - AVL trees - Height – searching – insertion and deletion of elements- AVL rotations

Graph: Terminologies – Matrix and list representation – Graph Traversals (DFS & BFS)

Search and Sorting techniques– Linear Search – Binary search - Bubble sort – Selection sort – Insertion Sort – Quick Sort – Merge Sort

Reference Books

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, “Introduction to Algorithms”, Fourth Edition, MIT Press 2022.
2. Sahni Sartaj, "Data Structures, Algorithms and Applications in C++", Silicon Press, 2011.
3. Aaron M. Tanenbaum, Moshe J. Augenstein and Yedidyah Langsam, "Data structures using C and C++", Prentice Hall, 2012.
4. Mark Allen Weiss, “Data structures and Algorithm Analysis in C++”, Fourth Edition, 2014.
5. Yashavant Kanetkar, “Data Structures Through C++”, 4th Edition, BPB Publications, 2022

Course Contents and Lecture Schedule

Module No.	Topic	No. of Periods
1	**INTRODUCTION**	
1.1	**A**bstraction - Data structures - Abstract Data Types	2
1.2	Primitive data structures – Types of data structures	1
1.3	Analysis of algorithms - Best, worst and average case time complexities	1
1.4	Complexity notations	1
2	**Arrays and Linked Lists**	
2.1	Data storage and primitive Operations with arrays	2

Module No.	Topic	No. of Periods
2.2	Singly linked lists	2
2.3	Doubly linked lists	2
2.4	Circular linked lists	1
2.5	Addition of Polynomials	1
2.6	Sparse matrix representation	2
3	**Stacks**	
3.1	Primitive operations - Sequential implementation	2
3.2	Linked Stacks	1
3.3	Recursion	1
3.4	Expression processing	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	1
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	1
5.4	Binary Search Tree -Search and Insertion	2
5.5	Deletion	1
5.6	Applications of BST	1
5.7	Need for balancing - AVL trees - Height – searching – insertion and deletion of elements- AVL rotations	2
6	**Graph**	
6.1	Terminologies – Matrix and list representation	1
6.2	Graph Traversals (DFS & BFS)	3
7	**Search and Sorting techniques**	
7.1	Linear Search & Binary search	1
7.2	Bubble sort, Selection sort	1
7.3	Insertion sort	1
7.4	Quick sort	1
7.5	Merge Sort	1
	Total	**46**

Course Designer(s):

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23DS340 DATABASE MANAGEMENT

Category	L	T	P	Credit
PCC	4	0	0	4

Preamble

This course aims to make it easier for students to comprehend the various DBMS software functionalities and perform numerous operations related to building, modifying, and maintaining databases for real-world applications. It also aims to help students understand various designing concepts, storage solutions, querying methods, and database management.

Prerequisite

Nil

Course Outcomes

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

CO1	Formulate Entity Relationship(ER) and Relational Models for a given application to design a consistent database	Apply
CO2	Develop a normalized database for a given application by incorporating various constraints like integrity and value constraints	Apply
CO3	Manipulate relational database using Structured Query Language and relational languages.	Apply
CO4	Apply data design and storage techniques for a given scenario	Apply
CO5	Construct Database with indexes and hash tables for the fast retrieval of data.	Apply
CO6	Illustrate different transaction and concurrency control mechanisms to preserve data consistency in a multi-user environment.	Analyze

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	L	L	L	L	L	-	-	L	L	-	L	M	M
CO2	S	M	M	L	L	L	-	-	L	L	-	L	M	M
CO3	S	M	M	L	L	L	-	-	L	L	-	L	M	M
CO4	S	M	M	L	M	M	-	-	L	L	-	L	M	M
CO5	S	M	S	L	M	S	-	-	L	L	-	L	M	M
CO6	S	S	S	L	M	S	-	-	L	L	-	L	M	M

S- Strong; M-Medium; L-Low

Assessment Pattern

CO	CAT1						Assignment 1						CAT2						Assignment2						Terminal					
Bloom's level	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
CO1	5	10	15						25																2	5	10			
CO2	5	10	20						25																2	5	15			
CO3		10	25						50					5	15										2	5	15			
CO4														5	15						25				2	10				
CO5													5	10	15						25				2		10			
CO6													5	10		15						50				5		10		
Total (in %)	100						100						100						100						100					

Syllabus

BASIC CONCEPTS: Introduction to databases – Conventional file Processing – Data Modelling for a database – Three level architecture – Data Independency –Components of a Database Management System (DBMS) – Advantages and disadvantages of a DBMS –System Environment – Users of DBMS – Transaction Management.

DATA MODELS: Introduction – Conceptual data modelling – Motivation - Entities, entity types, various types of attributes, relationships, relationship types - E/R Diagram(ERD) notation - Generalization– Aggregation – Conversion of ERD into relational schema – Introduction to Network data model and Hierarchical data model.

RELATIONAL DATA MODEL: Introduction – Keys, relational algebra operators: selection, projection, cross product, various types of joins, division, examples, tuple relation calculus, domain relational calculus.

RELATIONAL DATABASE MANIPULATION: Structured Query Language (SQL) - Basic data retrieval –nested queries - correlated and uncorrelated - SQL Join – Views.

DATABASE DESIGN THEORY: Functional dependencies – Normal forms - Dependency theory – Armstrong's axioms for FDs - Closure of a set of FDs, Minimal covers– 1NF, 2NF, 3NF and BCNF - Join dependencies and definition of 5NF – Examples.

DATA STORAGE AND INDEXING: Storage device Characteristics – Operations on file - Sequential files - Index Sequential files – Direct files – Indexing using Tree structures.

DATABASE SECURITY, INTEGRITY AND CONTROL: Security and Integrity threats – Defence mechanisms - Transaction processing – concepts - ACID properties - concurrency control - recovery methods.

Reference Books

1. Silberschatz A., Korth H. and Sudarshan S., “Database System Concepts”,7th edition McGraw Hill, 2021.
2. Elmasri R. and Navathe S.B., “Fundamentals of Database Systems”, Pearson Education, 2017.
3. Raghu Ramakrishnan and Johannes Gehrke, “Database Management System”, McGraw Hill, 2017.
4. Bipin C.Desai, “An Introduction to Database System”, Galgotia Publishers, 2012.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Periods
1	**Basic Concepts**	
1.1	Introduction to databases and conventional file processing	1
1.2	Data modelling for a database	2
1.3	Three-level architecture	1
1.4	Data independency	1
1.5	Components of a DBMS,Advantages and disadvantages of a DBMS	1
1.6	System environment & users of DBMS	1
1.7	Transaction management	1
2	**Data Models**	

Module No.	Topic	No. of Periods
2.1	Introduction	1
2.2	Conceptual data modelling and motivation	2
2.3	Entities, entity types, various types of attributes, relationships, relationship types	2
2.4	E/R Diagram notation	1
2.5	Generalization and aggregation	1
2.6	Conversion of ERD into relational schema	1
3	**Relational Data Model**	
3.1	Introduction	1
3.2	Keys	1
3.3	Relational algebra operators: selection, projection, cross product, various types of joins, division, examples	2
3.4	Tuple relation calculus, domain relational calculus	2
3.5	Network data model and Hierarchical data model	1
4	**Relational Database Manipulation**	
4.1	Structured Query Language (SQL) - Basic data retrieval	1
4.2	Nested queries - correlated and uncorrelated	1
4.3	SQL Join – Views	1
5	**Database Design Theory**	
5.1	Functional dependencies	1
5.2	Normal forms	2
5.3	Dependency theory and Armstrong's axioms for FDs	2
5.4	Closure of a set of FDs, minimal covers	3
5.5	1NF, 2NF, 3NF and BCNF Join dependencies and definition of 5NF	3
6	**Data Storage and Indexing**	
6.1	Storage device characteristics	1
6.2	Operations on file	1
6.3	Sequential files	1
6.4	Index Sequential files, direct files, indexing using Tree structures	1
7	**Database Security, Integrity and Control**	
7.1	Security and integrity threats	1
7.2	Defence mechanisms	1
7.3	Transaction processing concepts, ACID properties, concurrency control, recovery methods	2
	Total	**46**

Course Designer(s):

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23DS350 OPERATING SYSTEMS

Category	L	T	P	Credit
PCC	3	0	0	3

Preamble

The objective of this course is to introduce basic principles of operating systems which include memory management, device management, process management, file management and security & protection mechanisms with case studies from Windows and Linux operating systems.

Prerequisite

NIL

Course Outcomes

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

CO1	Describe the evolution, types, structure, and functions of operating systems	Understand
CO2	Demonstrate the process management functionalities of operating systems including threads, inter process communication and scheduling	Apply
CO3	Provide solutions for process synchronization and deadlocks	Analyze
CO4	Demonstrate the different memory management policies with paging, segmentation, and virtual memory schemes	Apply
CO5	Determine the mechanisms adopted for I/O and file systems in user applications	Apply
CO6	Execute Linux basic commands and shell scripts	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	L	L	-	L	-	-	-	L	L	-	L	L	L
CO2	S	M	M	L	L	L	-	-	L	L	-	L	L	L
CO3	S	S	S	L	L	L	-	-	L	L	-	M	L	L
CO4	S	M	M	L	L	L	-	-	L	L	-	L	L	L
CO5	S	M	M	L	L	L	-	-	L	L	-	L	L	M
CO6	S	M	S	L	S	L	-	-	L	L	-	M	L	M

S- Strong; M-Medium; L-Low

Assessment Pattern

CO	CAT1						Assignment 1						CAT2						Assignment2						Terminal					
Bloom's level	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
CO1	10	10																							2	5				
CO2	10	10	20						50																2	5	15			
CO3			20	20						50															2	5		15		
CO4													10	10	20						50				2	5	15			
CO5													10	10	20						25				2	5	10			
CO6															20						25						10			
Total (in %)	100						100						100						100						100					

Syllabus

Introduction: Need of Operating system, Operating system- Operations, functionalities, computing environments – Operating System structures

Process Management: Process states — Operations on process – Inter process communication - Thread concepts - Processor Scheduling – Implementation of scheduler - Case studies

Process Synchronization - Semaphores, Shared memory multiprocessors, Alternative Synchronization primitives, Monitors, Classical Synchronization problems, Implementation - Bounded Buffer Problem, Reader's Writer's Problem, Dining Philosopher's Problem - Deadlock prevention, avoidance, detection and recovery.

Memory Management: Swapping, Paging, Segmentation, Virtual Memory — Demand paging, Page Replacement algorithms – Implementation of algorithms

File & Storage Management: File System concepts and access methods, File structure, Allocation methods, free space management, Disk Structure, Disk Scheduling.

Linux Programming - Command Line and Shell Scripting Basics.

Reference Books

1. Abraham Silberschatz, Greg Gagne, Peter B. Galvin, "Operating System Concepts", 9th edition, Wiley, 2013.
2. Andrew Tanenbaum, Herbert Bos, "Modern Operating Systems", Fifth Edition, Pearson Education, 2014
3. William Stallings, "Operating systems Internal and Design Principle", Ninth Edition, Pearson Education, 2015
4. Carl Albing, Vossen, "bash Cookbook: Solutions and Examples for bash Users", 2nd Edition, O'Reilly, 2017.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Periods
1	**INTRODUCTION**	
1.1	Need of Operating system, Operating system- Operations	2
1.2	Functionalities - computing environments	1
1.3	Operating System structure	1
2	**Process Management**	
2.1	Process states — Operations on process	1
2.2	Interprocess communication	1
2.3	Thread concepts	1
2.4	Processor Scheduling - implementation	2
3	**Process Synchronization**.	
3.1	Semaphores	2

Module No.	Topic	No. of Periods
3.2	Shared memory multiprocessors, Alternative Synchronization primitives	1
3.3	Monitors, Classical Synchronization problems,	2
3.4	Implementation - Bounded Buffer Problem, Reader's Writer's Problem, Dining Philosopher's Problem	2
3.5	Deadlock prevention, avoidance, detection and recovery	2
4	**Memory Management**	
4.1	Swapping techniques	1
4.2	Paging	2
4.3	Segmentation	1
4.4	Virtual Memory — Demand paging	1
4.5	Page Replacement algorithms – Implementation of algorithms	2
5	**File & Storage Management**	
5.1	File System & access methods	2
5.2	Allocation methods	1
5.3	Free space management	1
5.4	Disk Structure, Disk Scheduling	2
6	**Linux Programming**	
6.1	Command Line Basics.	2
6.2	Shell Scripting	2
	Total	**35**

Course Designer(s):

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Dept. of Applied Mathematics and Computational Science

		Category	L	T	P	Credit
23DS370	**DATA STRUCTURES LAB**	PCC	0	0	4	2

Preamble

The objective of this lab is to provide hands-on experience to implement the algorithms for performing various operations on data structures. Students will gain practical knowledge by writing and executing programs in C++ using various data structures such as arrays, linked lists, stacks, queues, trees, graphs and search trees.

Prerequisite

- 23DS170 C Programming Lab
- 23DS280 Object Oriented Programming Lab

Course Outcomes

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

CO1	Design algorithms for the given problem specifications by choosing appropriate data structures and relevant operations.	Apply
CO2	Implement programs for the given algorithm specification using data structures	Apply
CO3	Implement programs to implement linear data structures: Stack and Queue using arrays and linked list in an application context.	Apply
CO4	Implement non-linear data structures: Graph, Trees in an application context	Apply
CO5	Implement algorithms that use sorting and searching as sub-procedures.	Apply
CO6	Prepare laboratory reports for the applications developed	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1:	S	M	L	-	-	M	-	-	L	-	-	-	M	M
CO2:	S	M	L	-	-	M	-	-	L	-	-	-	M	M
CO3:	S	M	L	-	-	M	-	-	L	-	-	-	M	M
CO4:	S	M	L	-	-	M	-	-	L	-	-	-	M	M
CO5:	S	M	L	-	-	M	-	-	L	-	-	-	M	M
CO6:	S	M	L	-	-	M	-	-	L	-	-	-	M	M

S- Strong; M-Medium; L-Low

List of Experiments

1. Search algorithms (Linear Search and Binary Search) using Arrays.
2. Sorting algorithms (Bubble/Insertion/Selection and Merge/Quick) using Arrays.
3. Implementation of Singly, Doubly and Circular Linked Lists
4. Stack implementation and Two-way stack implementation
5. Expression evaluation using a Stack
6. Implementation of Queue, Circular Queue
7. Binary Trees and traversals
8. Graph representation and traversal
9. Use of Data Structure libraries in the language

Reference Books

1. Thomas H. Cormen, Charles E. Leiserson, and Ronald L'Rivest, “Introduction to Algorithms”, Fourth Edition, MIT Press, 2022.
2. H.M. Deitel and P.J. Deitel, C “How to program Introducing C++ and Java”, Fourth Edition, Pearson Prentice Hall, (2012),Reprint 2020.
3. Reema Thareja “Computer fundamentals and programming in c”, Oxford University, Second edition, 2017

Course Designer(s):

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23DS380 RELATIONAL DATABASE LAB

Category	L	T	P	Credit
PCC	0	0	4	2

Preamble

This course aims to provide students with considerable knowledge to database design and E-R modelling. This course also provides students with hands-on training in SQL and programming languages that extend SQL.

Prerequisite

Nil

Course Outcomes

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

CO1	Model Entity Relationship with E-R diagrams for given application specification.	Apply
CO2	Design database schema considering normalization and relationships within database.	Apply
CO3	Write SQL queries to user specifications and design the queries that are scalable and optimised.	Apply
CO4	Develop triggers, procedures, user defined functions and design PLSQL programs in Databases	Apply
CO5	Use the database for a real world application and connect it from a front end application.	Apply
CO6	Use PL/SQL procedures for a solving a programming logic and develop package for database.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1.	S	S	L	-	L	-	-	-	-	-	-	-	M	L
CO2.	S	S	L	-	L	-	-	-	-	-	-	-	M	L
CO3	S	S	S	-	S	-	-	-	-	-	-	-	M	L
CO4	S	S	S	-	S	-	-	-	-	-	-	-	M	L
CO5.	S	S	S	-	S	-	-	-	-	-	-	-	M	L
CO6	S	M	M	-	S	-	-	-	-	-	-	-	M	L

S- Strong; M-Medium; L-Low

List of Experiments

1. Model ER diagram based on given project specifications
2. Design normalized relational database design on given project specification
3. SQL DDL-Create a SQL DDL Queries for a specific application.
4. SQL DML-Insert values into the Tables and Manipulate the data in it using DML commands.(Aggregate functions, Subqueries, Joins, Nested tables, Views)
5. PL/SQL Programming Procedures and functions
6. Implementation of Cursors.
7. Implementation of Triggers.
8. DCL and TCL commands
9. Development of front end application that connects with a database

Reference Books

1. Silberschatz A., Korth H. and Sudarshan S., “Database System Concepts”, McGraw Hill, 2021.
2. Elmasri R. and Navathe S.B., “Fundamentals of Database Systems”, Pearson Education, 2017.
3. Raghu Ramakrishnan and Johannes Gehrke, “Database Management System”, McGraw Hill, 2017.
4. Bipin C.Desai, “An Introduction to Database System” , Galgotia Publishers, 2012.

Course Designer(s):

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		Category	L	T	P	Credit
23DS410	**LINEAR ALGEBRA**	FC	4	0	0	4

Preamble

This course will enable students to solve the given system of linear equations through matrices, compute Eigen values, Eigen vectors and model to a quadratic form and construct a singular value decomposition for the given matrix, also perform diagonalization of a given matrix, verify whether the given set is a vector space or not, determine the matrix for the given linear transformation.

Prerequisite

Nil

Course Outcomes

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

CO1:	Apply the concept of Gauss elimination in solving linear equations and to find the inverse of a matrices	Apply
CO2:	Apply the concept of Eigen values and vectors to orthogonal diagonalizing a given matrix,	Apply
CO3:	Diagonalize a given matrix from quadratic form	Apply
CO4:	Apply the concept of vector spaces, linear independence, basis and dimensions to find Rank	Apply
CO5:	Apply the concept of linear transformation in matrices and geometry linear operators	Apply
CO6:	Apply the concepts of Inner product spaces and orthogonal projections to find QR decomposition and least squares	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO3.	L	L	L	M	-	-	-	-	-	-	-	-	L	M
CO4.	S	S	M	M	-	-	-	-	-	-	-	-	L	S
CO3	S	S	M	M	-	-	-	-	-	-	-	-	L	S
CO4	S	S	M	S	-	-	-	-	-	-	-	-	L	S
CO5	S	S	M	S	-	-	-	-	-	-	-	-	L	S
CO6	S	S	L	L	-	-	-	-	-	-	-	-	L	S

S- Strong; M-Medium; L-Low

Assessment Pattern

CO	CAT1						Assignment 1						CAT2						Assignment2						Terminal					
Bloom's level	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
CO1	2		20						30																	5	8			
CO2	4	10	20						35																2	5	10			
CO3	4	10	30						35																2		15			
CO4													4	10	30						35				2	5	12			
CO5													4		20						30				2		10			
CO6													2	10	20						35				2	5	15			
Total (in %)	100						100						100						100						100					

Syllabus

SYSTEM OF LINEAR EQUATIONS AND MATRICES:

System of linear equations, Gauss Elimination, Gauss – Jordan, Inverse of a matrix Using Gauss - Jordan.

EIGEN VALUES AND EIGEN VECTORS:

Introduction toEigen values and Eigen Vectors - Diagonalizing a matrix – Similarity and Orthogonal diagonalization – Applications of Eigen value problems – Quadratic forms

VECTOR SPACES:

Vector spaces and subspaces — Linear combination, Span, Linearindependence and dependence - Basis andDimension of a vector space - Change of basis.

LINEAR TRANSFORMATION:

Introduction to linear transformations — General Linear Transformations – Null space and Range – Rank and nullity – Row space and Column space - Matrices of general linear transformation.

INNERPRODUCT SPACES:

Inner product, Length, angle and orthogonality – Orthogonal sets – Orthogonal projections — Inner product spaces — Orthonormal basis: Gram-Schmidt process — QR Decomposition - Best Approximation, Least-squares.

Reference Books and Web Resources

1. David C. Lay, “Linear Algebra and its Applications", Pearson Education, 6th edition 2021.
2. Howard Anton and Chris Rorres, “Elementary Linear Algebra”, Wiley, 12th edition 2019.
3. Gilbert Strang, “Linear Algebra and its Applications”, Thomson Learning, 5th edition, 2016.
4. Steven J. Leon, “Linear Algebra with Applications”, Prentice Hall, 10th edition, 2021.
5. https://ilasic.org/
6. https://www.khanacademy.org/math/linear-algebra
7. https://mathworld.wolfram.com/topics/LinearAlgebra.html

Course Contents and Lecture Schedule

Module No.	Topic	No. of Periods
1	SYSTEM OF LINEAR EQUATIONS AND MATRICES:	
1.1	System of linear equations	1
1.2	Gauss Elimination	2
1.3	Gauss – Jordan	2
1.4	Inverse of a matrix using Gauss - Jordan	2
2	EIGEN VALUES AND EIGEN VECTORS:	
2.1	Introduction to Eigen values and Eigen Vectors	2
2.2	Diagonalizing a matrix	2

Module No.	Topic	No. of Periods
2.3	Similarity and Orthogonal diagonalization	2
2.4	Applications of Eigen value problems	1
2.5	Quadratic forms	2
3	VECTOR SPACES:	
3.1	Vector spaces and subspaces	2
3.2	Linear combination, Span, Linear independence and dependence	3
3.3	Basis and Dimension of a vector space	2
3.4	Change of basis.	2
4	LINEAR TRANSFORMATION:	
4.1	Introduction to linear transformations	1
4.2	General Linear Transformations	1
4.3	Null space and Range, Rank and nullity	2
4.4	Row space and Column space	2
4.5	Matrices of general linear transformation.	2
5	INNER PRODUCT SPACES:	
5.1	Inner product, Length, angle and orthogonality	2
5.2	Orthogonal sets – Orthogonal projections	2
5.3	Inner product spaces	1
5.4	Orthonormal basis: Gram-Schmidt process	2
5.5	QR Decomposition - Best Approximation	2
5.6	Least-squares	2
	Total	**44**

Course Designer:

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23DS420	PREDICTIVE ANALYTICS	Category	L	T	P	Credit
		PCC	4	0	0	4

Preamble

This course will enable students to apply specific statistical and regression analysis methods to develop and use various regression and classification predictive models and perform time series analysis with suitable techniques

Prerequisite

- 23DS220- Applied Statistics

Course Outcomes

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

CO1	Demonstrate simple linear regression models with appropriate validation of the models	Apply
CO2	Develop multiple linear regression models with appropriate validation of the models	Analyze
CO3	Formulate methods to improve linear regression models by addressing different data conflicts	Apply
CO4	Develop logistic regression models with appropriate validation of the models	Analyze
CO5	Demonstrate the application of decision trees in classification and regression	Apply
CO6	Perform time series analysis and forecasting using smoothing, moving average and different auto regressive models	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M	L	L	M	-	-	L	L	L	-	L	S	S
CO2	S	S	M	M	M	L	L	L	L	L	-	L	S	S
CO3	S	S	M	S	M	L	L	L	L	L	-	L	S	S
CO4	S	S	M	M	M	L	L	L	L	L	-	L	S	S
CO5	S	M	M	M	M	L	L	L	L	L	-	L	S	S
CO6	S	M	M	M	M	L	L	L	L	L	-	L	S	S

S- Strong; M-Medium; L-Low

Assessment Pattern

CO	CAT1						Assignment 1						CAT2						Assignment2						Terminal					
Bloom's level	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
CO1	5	10	20																						2		15			
CO2	5	10	10	20						50															2	5		10		
CO3		10	10						50																2	5	10			
CO4													5	5	5	20						50			2	5	10	5		
CO5													5	5	25						25				2		10			
CO6														10	20						25					5	10			
Total (in %)	100						100						100						100						100					

Syllabus

SIMPLE LINEAR REGRESSION(SLR): Correlation analysis, Model building, Estimation and interpretation of coefficients, Validation of SLR model, Coefficient of determination, Significance test, Residual analysis, Outlier analysis, Confidence and Prediction intervals.

MULTIPLE LINEAR REGRESSION(MLR): Model building, Estimation and interpretation of coefficients, Validation of MLR model: Adjusted R square, Bias and Variance, Underfitting and overfitting, Crossvalidation, Categorical variables, heteroscedasticity, Multi-collinearity and Variance Inflation Factor, Auto correlation, Outlier analysis, Feature selection and transformations, Regularization

LOGISTIC AND MULTINOMIAL REGRESSION: Logistic function, Estimation of probability using Logistic regression, Model validation:Wald Test, Hosmer Lemshow Test, Classification Table and ROC curve, Feature selection, Multinomial Logistic regression

DECISION TREES : Introduction,Gini Impurity index and Entropy, Classification and Regression trees

TIME SERIES ANALYSIS: Time-series data components, Forecasting techniques, Moving average, Exponential Smoothing: Single, Double and Triple, Regression model for forecasting, Autoregressive Models-AR,MA,ARMA, ARIMA models.

CASE STUDIES

Reference Books and web resources

1. Anderson, Sweeney and Williams, “Statistics for business and economics”, Cengage Learning, 13th Edition, ,2018
2. Trevor Hastie, Robert, Jerome, “The elements of statistical learning: Datamining, Inference and Prediction”, 2nd Edition, 2017.
3. Eric Seigel, “Predictive Analytics: The Power to Predict Who Will Click, Buy, Lie, or Die”, 2016
4. Ronald E. Walpole, Raymond H. Meyers, Sharon L. Meyers, “Probability and Statistics for Engineers and Scientists”, Pearson Education, 9th Edition, 2022
5. U. Dinesh Kumar, ”Business Analytics: The Science of Data-Driven Decision Making”, Wiley, 2017
6. Introduction to Predictive Modeling – Coursera

Course Contents and Lecture Schedule

Module No.	Topic	No. of Periods
1	**SIMPLE LINEAR REGRESSION(SLR)**:	
1.1	Correlation analysis	1
1.2	Model building, Estimation and interpretation of coefficients,	2
1.3	Coefficient of determination, Significance Testing	2
1.4	Residual analysis	2
1.5	Outlier analysis	1
1.6	Confidence and Prediction intervals	2

Module No.	Topic	No. of Periods
2	**MULTIPLE LINEAR REGRESSION**	
2.1	Model building, Estimation and interpretation of coefficients	2
2.2	Validation of MLR model: Adjusted R square , Bias and Variance, Underfitting and overfitting, cross validation techniques	2
2.3	Categorical variables, heteroscedasticity, Multi-collinearity and Variance Inflation Factor	2
2.4	Auto correlation	1
2.5	Outlier analysis	1
2.6	Feature selection and transformations, Regularization	2
3	**LOGISTIC AND MULTINOMIAL REGRESSION**	
3.1	Logistic function, Estimation of probability using Logistic regression	1
3.2	Wald test	2
3.3	Hosmer Lemshow Test	1
3.4	Classification Table and ROC curve	2
3.5	Feature selection, Multinomial Logistic regression	2
4	**DECISION TREES**	
4.1	Gini Impurity index and Entropy	3
4.2	Classification decision trees	2
4.3	Regression trees	2
5	**TIME SERIES ANALYSIS**	
5.1	Time-series data components	1
5.2	Forecasting techniques, Moving average,	1
5.3	Exponential Smoothing: Single, Double and Triple	2
5.4	Regression model for forecasting	2
5.5	AR,MA,ARMA, ARIMA models	2
5.6	Case Studies	2
	Total	**45**

Course Designer(s):

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		Category	L	T	P	Credit
23DS430	**DESIGN AND ANALYSIS OF ALGORITHMS**	PCC	3	1	0	4

Preamble

This course will enable students to solve a given problem using an algorithm. Also, it enables them to mathematically analyze the algorithms for its efficiency and effectiveness for choosing a better solution to real time algorithmic problems.

Prerequisite

- 23DS330 Data Structures

Course Outcomes

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

CO1	Summarize the relevance of algorithms for computational problems solving and real time applications.	Understand
CO2	Differentiate different algorithmic approaches, techniques and methods.	Understand
CO3	Apply paradigms like divide and conquer, greedy and dynamic programming for a given algorithm.	Apply
CO4	Apply optimization techniques for improving the efficiency of graph-based algorithms to solve complex problems.	Apply
CO5	Analyze the worst-case, best-case and average-case running time of algorithms using asymptotics.	Analyze
CO6	Evaluate polynomial reductions for standard problems with an understanding of the intractable complexity classes like NP- Complete and NP-hard.	Evaluate

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M	-	-	-	-	-	-	-	-	-	-	L	L
CO2	S	M	-	-	-	-	-	-	-	-	-	-	L	L
CO3	S	S	-	-	-	-	-	-	-	-	-	-	L	L
CO4	S	S	M	-	-	L	L	-	-	-	-	-	L	L
CO5	S	S	L	-	-	-	-	-	-	-	-	-	L	L
CO6	S	S	L	-	-	-	-	-	-	-	-	-	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern

CO	CAT1						Assignment 1						CAT2						Assignment2						Terminal					
Bloom's level	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
CO1	5	10																							2	10				
CO2	10	10							30																2	10				
CO3		10	30						30																2		20			
CO4									40				5	10	20										2		20			
CO5	5			20									5	10		20						50			2	5		10		
CO6														10	10		10					50				5			10	
Total (in %)	100						100						100						100						100					

Syllabus

INTRODUCTION: Fundamentals of algorithmic problem solving - Methods of specifying an algorithm – proving the correctness – analyzing an algorithm, Asymptotic notations, Recurrences – Master theorem.

DIVIDE AND CONQUER: Integer multiplication, matrix multiplication

GREEDY METHOD: Minimum cost spanning tree (Kruskal and Prim‟s algorithms), topological sorting, Huffman codes and data compression.

DYNAMIC PROGRAMMING: Principles of dynamic programming – 0/1 knapsack problem, all pairs shortest problem, travelling salesman problem.

GRAPHS: Definition – Representations– Network representation, shortest path- Dijkstra's algorithm, Graph search methods (Breadth first and depth first traversals)- Applications of depth first search- Biconnectivity.

NP AND COMPUTATIONAL INTRACTABILITY: Basic concepts – Polynomial time reductions, efficient certification and NP, NP hard and NP complete problems.

COPING WITH NP-COMPLETENESS: Backtracking-n queen's problem, Graph coloring problem - Branch and bound - 0/1 knap sack problem, traveling salesman problem, Approximation algorithm.

Reference Books

1. Thomas H. Cormen, Charles E. Leiserson, and Ronald LRivest, —Introduction to Algorithms, Fourth Edition, MIT Press, 2022. (Chapters: 1 to 5, 15, 16, 17, 34 & 35).
2. M.A.Weiss, "Data Structures and Algorithm Analysis in C++", Pearson Education Asia, 2013.
3. Jon Kleinberg and Eve Tardos, "Algorithm Design", Pearson Education, 2012
4. Anany Levitin, "Introduction to Design and Analysis of Algorithms", Pearson Education, 2012.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Periods
1	**Introduction**	1
1.1	Fundamentals of algorithmic problem solving	1
1.2	Methods of specifying an algorithm	1
1.3	proving the correctness	1
1.4	analyzing an algorithm	1
1.5	Asymptotic notations	1
1.6	Recurrences	1
1.7	Master theorem	2
2	**Divide and Conquer Method (DCM)**	
2.1	Introduction to DCM	1

Module No.	Topic	No. of Periods
2.2	Integer Multiplication	1
2.3	Matrix multiplication	1
3	**Greedy Method**	
3.1	Minimum cost spanning tree (Kruskal and Prim's algorithms)	2
3.2	Topological sorting	1
3.3	Huffman codes	2
3.4	Data compression	1
4	**Dynamic programming**	
4.1	Principles of Dynamic programming	1
4.2	0/1 knapsack problem	1
4.3	All pairs shortest problem	1
4.4	Travelling salesman problem	1
5	**Graphs**	
5.1	Definition and Representations	1
5.2	Network representation	1
5.3	Shortest path- Dijkstra's algorithm	2
5.4	Graph search methods (Breadth first and depth first traversals)	2
5.5	Applications of depth first search	1
5.6	Biconnectivity.	1
6	**NP and Computational Intractability**	
6.1	Basic concepts	1
6.2	Polynomial time reductions	1
6.3	Efficient certification and NP	1
6.4	NP hard problem	1
6.5	NP complete problems	1
7	**Coping with NP Completeness**	
7.1	Backtracking	1
7.2	N queen's problem	1
7.3	Graph coloring problem	2

Module No.	Topic	No. of Periods
7.4	branch and bound	1
7.5	0/1 knap sack problem	1
7.6	Travelling salesman problem	2
7.7	Approximation algorithm	1
	Total	**44**

Course Designer:

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23DS440	ADVANCED DATA STRUCTURES	Category	L	T	P	Credit
		PCC	4	0	0	4

Preamble

This course aims at facilitating the student to understand the various advanced data structures, their operations and apply them in real world problems.

Prerequisite

- 23DS330 Data Structures

Course Outcomes

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

CO1	Demonstrate the operations of Balanced Binary search trees and related applications	Apply
CO2	Implement algorithms for Multiway Search Trees	Apply
CO3	Explain the concept of Multi-dimensional Search Trees	Understand
CO4	Implement Priority Queues with Binary heaps	Apply
CO5	Show the avoidance of collisions in the hash tables using collision resolution techniques including open and closed hashing techniques.	Apply
CO6	Explain the implementation of priority queues with leftist heaps and binomial heap	Understand
CO7	Implement suitable technique and algorithms for disjoint set operations	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M	L	L	L	M	-	-	L	L	-	L	M	L
CO2	S	M	L	L	L	M	-	-	L	L	-	L	M	L
CO3	S	-	L	L	-	-	-	-	-	-	-	-	M	L
CO4	S	M	L	L	L	M	-	-	L	L	-	M	M	L
CO5	S	M	L	L	L	M	-	-	L	L	-	M	M	L
CO6	S	-	L	L	-	-	-	-	-	L	-	M	M	L
CO7	S	M	L	L	L	M	-	-	L	L	-	L	M	L

S- Strong; M-Medium; L-Low

Assessment Pattern

CO	CAT1						Assignment 1						CAT2						Assignment2						Terminal					
Bloom's level	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
CO1	10		20						50																		15			
CO2	5	20	20						50																5		10			
CO3	5	20																							5	5				
CO4													5	10	20						30						15			
CO5													5		20						40					5	15			
CO6													5	10											5	5				
CO7														5	20						30						15			
Total (in %)	100						100						100						100						100					

Syllabus

Balanced Binary Search Trees: – Binary Search Tree - Red Black Tree –Splay Tree

Hash Table: Hash function – Separate chaining – Open addressing – Linear probing – Quadratic probing – Double hashing – rehashing

Priority Queues (Heaps): Binary Heaps- Leftist Heaps - Property and operations- Binomial heap, Fibonacci Heap

Multiway Search Trees: B-Tree, - B+ trees, B*-trees, Tries, Application on Tries: Pattern Searching, String matching, Digital search trees, Dictionary applications

Multidimensional Search Trees: Range search–k-d trees- Quad trees.

Disjoint Sets: Disjoint set operations-linked list representation of disjoint sets, disjoint set forests, tree representation, union by rank – Applications of disjoint sets

Reference Books

1. Thomas H. Cormen, Charles E. Leiserson and Ronald L. Rivest, “Introduction to Algorithms”, Fourth Edition, MIT Press, 2022.
2. Karumanchi Narasimha , “Data Structures and Algorithms Made Easy”, 2016
3. Devraj Ganguly, “ Introduction To Data Structures And Algorithms: A Conceptual Guide”, 2021

Course Contents and Lecture Schedule

Module No.	Topic	No. of Periods
1	**Balanced Binary Search Trees**	
1.1	Binary Search Tree	1
1.2	Red Black Tree	2
1.3	Splay Tree	2
	Practice Problems	2
2	**Hash Table:**	
2.1	Hash function	1
2.2	Separate chaining	1
2.3	Open addressing	1
2.4	Linear probing, Quadratic probing	1
2.5	Double hashing	2
2.6	Rehashing	1
	Practice Problems	2
3	**Priority Queues (Heaps):**	

Module No.	Topic	No. of Periods
3.1	Binary Heaps – property and operations	1
3.2	Leftist Heaps- property and operations	2
3.3	Binomial heap – property and operations	2
3.4	Fibonacci Heap – property and operations	2
	Practice Problems	2
4	**Multiway Search Trees:**	
4.1	B-Tree	1
4.2	B+ Tree	1
4.3	B* Tree	1
4.4	Tries	1
4.5	Application on Tries:,	1
4.6	Pattern Searching and String Matching	1
4.7	Digital search trees and Dictionary applications	1
	Practice Problems	2
5	**Multidimensional Search Trees:**	
5.1	k-d trees	1
5.2	Quad trees	1
	Practice Problems	2
6	**Disjoint Sets:**	
6.1	Disjoint set operations	1
6.2	Linked list representation of disjoint sets	1
6.3	Disjoint set forests -tree representation	1
6.4	Union by rank, Applications of Disjoint sets	1
	Practice Problems	2
	Total	**44**

Course Designer(s):

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		Category	L	T	P	Credit
23DS450	**SOFTWARE ENGINEERING**	PCC	3	0	0	3

Preamble

This course will provide knowledge of software engineering discipline, to analyze risk in software design and quality, to introduce the concept of advance software methodology and to plan, design, develop and validate the software project.

Prerequisite

NIL

Course Outcomes

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

CO1: Identify appropriate process models in the software industry according to given circumstances	Understand
CO2: Demonstrate the concepts of DevOps and mastering aspects of software development and automated building.	Understand
CO3: Apply Project Management and Requirement analysis principles to S/W project development.	Apply
CO4: Develop Design models in software engineering effectively, the architecture, the user interface, and the component level.	Apply
CO5: Analyze the cost estimate and problem complexity using various estimation techniques	Analyze
CO6: Generate test cases using the techniques involved in selecting: (a) White Box testing (b) Block Box testing	Analyze

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	L	-	-	-	-	-	-	-	-	-	-	M	L
CO2	M	L	-	-	-	M	-	-	-	-	-	-		L
CO3	S	M	L	-	-	-	-	S	-	-	-	-	L	L
CO4	S	M	L	-	-	-	-	-	S	-	-	-	L	
CO5	S	S	M	-	-	-	-	-	-	-	-	-	L	
CO6	S	S	M	-	-	-	-	-	-	M	-	-	L	L

S- Strong; M-Medium; L-Low

Assessment Pattern

CO	CAT1						Assignment 1						CAT2						Assignment2						Terminal					
Bloom's level	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
CO1	10	10						20																	10					
CO2	10	10						20																		10				
CO3			60						60																	10	20			
CO4													10		20						40						20			
CO5														10		30						30				5		10		
CO6																30						30				5		10		
Total (in %)	100						100						100						100						100					

Syllabus

Software engineering - Process framework - Umbrella activities. Software process models - Waterfall - Prototyping - evolutionary process model - Agile model - Scrum Teams and Artifacts - Sprint Planning Meeting - Daily Scrum Meeting - Sprint Review Meeting - DevOps. **Requirements Engineering** - Inception - Elicitation - Elaboration - Negotiation - Specification - Validation. Requirements Management - Identifying Stakeholders - Non-functional Requirements - Traceability. Requirements Gathering - Collaborative Requirements Gathering - Usage Scenarios - Elicitation Work Products - Developing Use Cases -Building the Analysis Model - Elements of the Analysis Model - Validating Requirements.

Requirements modelling - Business Use Case, Class-Based Modelling - Functional Modelling - Behavioral Modelling. Design concepts

Design model - Software Architecture - User Experience Design - Mobile App design. Software costs estimation. Software Quality Assurance.

Software testing - Black Box - White Box - Unit - Integration - System - Validation.

Reference Books

1. Roger Pressman, Software Engineering: A Practitioners Approach, (9th Edition), McGraw Hill, 2020. Chapters 1,2,3, 7, 8, 9, 10, 12, 13, 17, 19, 20, 25.
2. Ian Somerville, Software Engineering, 10th edition, Pearson, 2021.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Periods
1	**Software**	
1.1	Software Engineering- Process framework	1
1.2	Umbrella activities.	1
1.3	Software process models	1
2	**Life Cycle Models**	
2.1	Water fall, incremental, spiral,	2
2.2	WINWIN spiral,	1
2.3	evolutionary, prototyping	2
2.4	Agile Process Models, Scrum Teams and Artifacts - Sprint Planning Meeting - Daily Scrum Meeting - Sprint Review Meeting	2
2.5	Devops	1
3	**Requirements Engineering tasks**	

Module No.	Topic	No. of Periods
3.1	Inception - Elicitation - Elaboration	2
3.2	Negotiation - Specification - Validation	2
3.3	Requirements Management - Identifying Stakeholders -	2
3.4	Non-functional Requirements - Traceability.	2
3.5	Collaborative Requirements Gathering	1
3.6	Usage Scenarios - Elicitation Work Products	1
3.7	Developing Use Cases -Building the Analysis Model	1
3.8	Elements of the Analysis Model - Validating Requirements.	2
4	**Requirements modelling**	
4.1	Business Use Case	1
4.2	Class-Based Modelling	1
4.3	Functional Modelling	1
4.4	Behavioral Modelling	1
5	**Design concepts**	
5.1	Software Architecture	1
5.2	User Experience Design	1
5.3	Software costs estimation	1
5.4	Software Quality Assurance	1
6	**Software testing**	
6.1	Black Box - White Box	1
6.2	Unit - Integration -	1
6.3	System-Validation.	1
	Total	35

Course Designer(s):

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		Category	L	T	P	Credit
23DS470	**PREDICTIVE ANALYTICS LAB**	PCC	0	0	4	2

Preamble

This course will provide a practical application of specific statistical and regression analysis methods to develop and use various regression and classification predictive models and perform time series analysis with suitable techniques based on the real time requirements

Prerequisite

- 23DS270 Python Programming And Applied Statistics Lab

Course Outcomes

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

CO1	Implement linear regression models with appropriate data collection, pre-processing and postprocessing techniques	Apply
CO2	Implement logistic regression models with appropriate data collection, pre-processing and postprocessing techniques	Apply
CO3	Implement decision trees algorithms for classification and regression	Apply
CO4	Perform time series analysis and forecasting using different auto regressive models	Apply
CO5	Design a project or research presentation with an identified societal problem in a team	Create
CO6	Write technical reports for the tasks performed	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M	M	M	S	L	L	L	M	L	-	M	S	S
CO2	S	M	M	M	S	L	L	L	M	L	-	M	S	S
CO3	S	M	M	M	S	L	L	L	M	L	-	M	S	S
CO4	S	M	M	M	S	L	L	L	M	L	-	M	S	S
CO5	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CO6	-	-	-	-	L	L	L	M	S	L	-	L	S	S

S- Strong; M-Medium; L-Low

List of Experiments

Experiments shall be done on data available on Universal repositories / self-collected survey data in Python/R

- Implement and validate Simple Linear regression after appropriate data collection and pre-processing
- Implement and validate Multi Linear regression after appropriate data collection and pre-processing with appropriate testing for multicollinearity (with categorical variables

- Implement and validate Logistic regression
- Implement cross validation in the results obtained for Linear and logistic regression
- Implementing improved performance measures in the results obtained for Linear and logistic regression (Features subset selection, Regularization)
- Implementing Decision trees for classification and regression
- Time Series analysis with moving average and smoothing methods
- Time Series analysis with ARIMA
- Mini project / Research work presentation processing real world user requirements/ research requirements and implementing the same.

Reference Books and web resources

1. Wes McKinney, “Python for Data Analysis”, Oreilly, 3rd Edition, 2022
2. Alvaro Fuentes, “Hands-On Predictive Analytics with Python: Master the complete predictive analytics process, from problem definition to model deployment”, Packt, 2018
3. Basic Data Processing and Visualization – Coursera
4. Data Analysis with R Specialization – Coursera

Course Designer(s):

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23DS480 JAVA PROGRAMMING LAB

Category	L	T	P	Credit
PCC	0	0	6	3

Preamble

This course will help the students how to use the Java programming language constructs to create solutions for problems in the real world and develop Java programs for user defined specifications.

Prerequisite

- 23DS280 Object Oriented Programming Lab

Course Outcomes

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

CO1	Develop Java programs using OOP Principles and proper program structuring.	Apply
CO2	Develop Java programs to implement exception handling and Multithreading applications.	Apply
CO3	Implement Java programs using packages, Streams, interfaces and collection classes	Apply
CO4	Use API that allows Java program to access the database management systems.	Apply
CO5	Implement Java Programs for Events and interactivity using Layout Manager.	Apply
CO6	Create Java programs for network chatting and remote method development to construct an internet application.	Apply
CO7	Implement server side and client-side application using java servlet and java scripting language.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1.	S	M	S	-	L	-	-	-	-	-	-	-	M	L
CO2.	S	S	S	L	L	-	-	-	-	-	-	-	S	M
CO3	S	S	S	M	M	L	-	-	L	-	-	-	S	M
CO4	S	S	S	M	M	L	-	L	M	-	L	-	S	M
CO5	S	S	S	M	M	-	-	-	M	-	-	-	S	M
CO6	S	S	S	M	M	L	-	L	M	-	M	L	S	M
CO7	S	S	S	M	M	L	-	L	M	-	M	L	S	M

S- Strong; M-Medium; L-Low

List of Experiments

Develop Java Programs for

1. Use of Objects
2. Using classes and inheritance
3. JNI concepts
4. Multithread applications
5. Exception handling
6. Implementing packages and interfaces
7. Streams
8. Java Collection and utility Classes
9. JDBC Connectivity using different statements
10. Applet program for Animation text, images and sounds
11. Events and interactivity using AWT and Java swing.
12. Socket program for network chatting using Inter Process communication.
13. Client server application using RMI techniques
14. Java Servlets
15. Simple front-end design with validation script

Mini Project in Java

Reference Books:

1. Herbert Schildt, “Java: The Complete Reference-12th Edition”, McGraw Hill, 2021.
2. Paul Deitel and Harvey Deitel, “Java How to Program (Early Objects)”, Pearson, Eleventh Edition, 2017.

Course Designer(s):

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