MANONMANIAM SUNDARANAR UNIVERSITY

Tirunelveli 627012, INDIA

DEPARTMENT OF MATHEMATICS

Vision of the University

To provide quality education to reach the un-reached

Mission of the University

- *To conduct research, teaching and outreach programmes to improve conditions of human living*
- *To create an academic environment that honours women and men of all races, caste, creed, cultures an atmosphere that values intellectual curiosity, pursuit of knowledge, academic freedom and integrity*
- *To offer a wide variety of off-campus educational and training programs, including the use of information technology, to individuals and groups.*
- *To develop partnership with industries and government so as to improve the quality of the workplace and to serve as catalyst for economic and cultural development*
- *To provide quality / inclusive education, especially for the rural and un-reached segments of economically downtrodden students including women, socially oppressedand differently abled.*

Vision of the Department

To attain academic excellence at the international level at par with leading research institutions

Mission of the Department

To develop mathematical skills, knowledge and critical thinking in the minds of young students

M. Sc. Mathematics

Syllabus

For 2023-2024 onwards

CONTENTS

Preamble

Mathematics is one of the fundamental disciplines in science. It is the basic forall the disciplines. This two year program, consisting four semesters, aims at providing basic tools and exposure to students who intend to pursue Master Degree in Mathematics at the inter- national level.

- ❖ Core and elective courses are planned to suit competitive examinations like NET and SLET.
- ❖ Students undergoing this programme will have the opportunity of choosingresearch / teaching at leading research institutions or a career in corporate sectors.
- ❖ To enable the students to have a thorough exposure to the different branches of Mathematics so as to gain a comprehensive knowledge of Mathematics.
- ❖ To cultivate logical thinking and analytical skills which sharpens their concentration and provides patience to grapple with life outside the campus.

Any graduate with an aggregate of 50% marks in Mathematics or Applied Mathematics is eligible to apply for admission to the course. Relaxation for SC/ST students will be given as per norms of the Government of Tamil Nadu.

An entrance examination (objective type questions) will be conducted for eligible applicants. The merit list will be prepared with 50% marks for entrance examination and 50% marks for Part III score in B.Sc. Then admission will be based on merit and reservation policy of the Government of Tamil Nadu

Three domains:

(i) Cognitive Domain

(Lower levels: K1: Remembering ; K2: Understanding ; K3: Applying;

Higher levels: K4: Analysing ; K5: Evaluating; K6: Creating)

(ii) Affective Domain

(iii) Psychomotor Domain

TANSCHE REGULATIONS ON LEARNING OUTCOMES-BASED CURRICULUM FRAMEWORK FOR POSTGRADUATE EDUCATION	
Programme	**M.Sc., Mathematics**
Programme Code	
Duration	**PG - 2 years**
Programme Outcomes (Pos)	**PO1: Problem Solving Skill** Apply knowledge of Management theories and Human Resource practices to solve business problems through research in Global context. **PO2: Decision Making Skill** Foster analytical and critical thinking abilities for data-based decision-making. **PO3: Ethical Value** Ability to incorporate quality, ethical and legal value-based perspectives to all organizational activities. **PO4: Communication Skill** Ability to develop communication, managerial and interpersonal skills. **PO5: Individual and Team Leadership Skill** Capability to lead themselves and the team to achieve organizational goals. **PO6: Employability Skill** Inculcate contemporary business practices to enhance employability skills in the competitive environment. **PO7: Entrepreneurial Skill** Equip with skills and competencies to become an entrepreneur. **PO8: Contribution to Society** Succeed in career endeavors and contribute significantly to society. **PO 9 Multicultural competence** Possess knowledge of the values and beliefs of multiple cultures and a global perspective.

	PO 10: Moral and ethical awareness/reasoning Ability to embrace moral/ethical values in conducting one's life.
Programme Specific Outcomes (PSOs)	**PSO1 – Placement** To prepare the students who will demonstrate respectful engagement with others' ideas, behaviors, beliefs and apply diverse frames of reference to decisions and actions. **PSO 2 - Entrepreneur** To create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate startups and high potential organizations. **PSO3 – Research and Development** Design and implement HR systems and practices grounded in research that comply with employment laws, leading the organization towards growth and development. **PSO4 – Contribution to Business World** To produce employable, ethical and innovative professionals to sustain in the dynamic business world. **PSO 5 – Contribution to the Society** To contribute to the development of the society by collaborating with stakeholders for mutual benefit.

Template for M.Sc. Mathematics Programme

Semester–I	Credit	Hours	Semester-II	Credit	Hours	Semester-III	Credit	Hours	Semester–IV	Credit	Hours
1.1. Core-I	5	7	2.1. Core-IV	5	6	3.1. Core-VII	5	6	4.1. Core-XI	5	6
1.2 Core-II	5	7	2.2 Core-V	5	6	3.2 Core-VIII	5	6	4.2 Core-XII	5	6
1.3 Core – III	4	6	2.3 Core – VI	4	6	3.3 Core – IX	5	6	4.3 Project with viva voce	7	10
1.4 Discipline Centric Elective -I	3	5	2.4 Discipline Centric Elective – III	3	4	3.4 Core – X	4	5	4.4Elective - VI (Industry / Entrepreneurship)	3	4
1.5 Generic Elective-II:	3	5	2.5 Generic Elective -IV:	3	4	3.5 Discipline Centric Elective - V	3	4	4.5 Skill Enhancement course / Professional Competency Skill	2	4
			2.6 NME I	2	4	3.6 NME II	2	3	4.6 Extension Activity	1	
						3.7 Internship/ Industrial Activity	2	-			
	20	**30**		**22**	**30**		**26**	**30**		**23**	**30**
Total Credit Points -91											

Choice Based Credit System (CBCS), Learning Outcomes Based Curriculum Framework (LOCF) Guideline Based Credits and Hours Distribution System for MSc Mathematics

First Year – Semester – I

Part	List of Courses	Credits	No. of Hours
	Core – I	5	7
	Core – II	5	7
	Core – III	4	6
	Elective – I Discipline Centric	3	5
	Elective – II Generic	3	5
		20	**30**

Semester-II

Part	List of Courses	Credits	No. of Hours
	Core – IV	5	6
	Core – V	5	6
	Core – VI	4	6
	Elective – III Discipline Centric	3	4
	Elective – IV Generic	3	4
	NME I	2	4
		22	**30**

Second Year – Semester – III

Part	List of Courses	Credits	No. of Hours
	Core – VII	5	6
	Core – VIII	5	6
	Core – IX	5	6
	Core – X	4	5
	Elective – V Discipline Centric	3	4
	NME II	2	3
	Internship / Industrial Activity	2	-
		26	**30**

Semester-IV

Part	List of Courses	Credits	No. of Hours
	Core – XI	5	6
	Core – XII	5	6
	Project with viva voce	7	10
	Elective – VI (Industry Entrepreneurship)	3	4
	Skill Enhancement Course / Professional Competency Skill	2	4
	Extension Activity	1	-
		23	**30**

Total 91 Credits

M.Sc., Mathematics

Programme Specific Outcomes:

PSO1: Acquire good knowledge and understanding, to solve specific theoretical & applied problems in different area of mathematics & statistics.

PSO2: Understand, formulate, develop mathematical arguments, logically and use quantitative models to address issues arising in social sciences, business and other context /fields.

PSO3: To prepare the students who will demonstrate respectful engagement with other's ideas, behaviors, beliefs and apply diverse frames of references to decisions and actions.

PSO4: To create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate startups and high potential organizations.

PSO5: To encourage practices grounded in research that comply with employment laws, leading the organization towards growth and development.

Mapping of Course Learning Outcomes (CLOs) with Programme Outcomes (POs) and Programme Specific Outcomes (PSOs)can be carried out accordingly, assigning the appropriate level in the grids:

	Pos							PSOs		
	1	2	3	4	5	6	…	1	2	…
CLO1										
CLO2										
CLO3										
CLO4										
CLO5										

2 b. Structure of Course

Course Code	**Course Name**		**Credits**
Lecture Hours: (L) per week	**Tutorial Hours : (T) per week**	**Lab Practice Hours: (P)per week**	**Total: (L+T+P) per week**
Course Category :	**Year & Semester:**	**Admission Year:**	
Pre-requisite			

Links to other Courses		
Learning Objectives: (for teachers: what they have to do in the class/lab/field)		
Course Outcomes: (for students: To know what they are going to learn) **CO1:** **CO2:** **CO3:** **CO4:** **CO5:**		
Recap: (not for examination) Motivation/previous lecture/ relevant portions required for the course) [This is done during 2 Tutorial hours)		
Units	**Contents**	**Required Hours**
I		**18**
II		**18**
III		**18**
IV		**18**
V		**18**
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)	
Skills acquired from the course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill	
Learning Resources: • **Recommended Texts** • **Reference Books** • **Web resources**		
Board of Studies Date:		

3. Learning and Teaching Activities

3.1 Topic wise Delivery method

Hour Count	Topic	Unit	Mode of Delivery

3.2 Work Load

The information below is provided as a guide to assist students in engaging appropriately with the course requirements.

Activity	Quantity	Workload periods
Lectures	60	60
Tutorials	15	15
Assignments	5	5
Cycle Test or similar	2	4
Model Test or similar	1	3
University Exam Preparation	1	3
	Total	90 periods

1. **Tutorial Activities**

Tutorial Count	Topic

2. **Laboratory Activities**
3. **Field Study Activities**
4. **Assessment Activities**

Assessment Principles:

Assessment for this course is based on the following principles

1. Assessment must encourage and reinforce learning.
2. Assessment must measure achievement of the stated learning objectives.
3. Assessment must enable robust and fair judgments about student performance.
4. Assessment practice must be fair and equitable to students and give them the opportunity to demonstrate what they learned.
5. Assessment must maintain academic standards.

Assessment Details:

Assessment Item	Distributed Due Date	Weightage	Cumulative Weightage
Assignment 1	3rd week	2%	2%
Assignment 2	6th Week	2%	4%
Cycle Test – I	7th Week	6%	10%
Assignment 3	8th Week	2%	12%
Assignment 4	11th Week	2%	14%
Cycle Test – II	12th Week	6%	20%
Assignment 5	14th Week	2%	22%
Model Exam	15th Week	13%	35%
Attendance	All weeks as per the Academic Calendar	5%	40%
University Exam	17th Week	60%	100%

CONTENTS

a. Academic Schedule
b. Students Name List
c. Time Table
d. Syllabus
e. Lesson Plan
f. Staff Workload
g. Course Design(content, Course Outcomes(COs), Delivery method, mapping of COs with Programme Outcomes(POs), Assessment Pattern in terms of Revised Bloom's Taxonomy)
h. Sample CO Assessment Tools.
i. Faculty Course Assessment Report(FCAR)
j. Course Evaluation Sheet
k. Teaching Materials(PPT, OHP etc)
l. Lecture Notes
m. Home Assignment Questions
n. Tutorial Sheets
o. Remedial Class Record, if any.
p. Projects related to the Course
q. Laboratory Experiments related to the Courses
r. Internal Question Paper
s. External Question Paper
t. Sample Home Assignment Answer Sheets
u. Three best, three middle level and three average Answer sheets
v. Result Analysis (CO wise and whole class)
w. Question Bank for Higher studies Preparation (GATE/Placement)
x. List of mentees and their academic achievements

Credit Distribution for M.Sc. Mathematics

Illustration – I

	First Year Semester-I	**Credit**	**Hours per week (L/T/P)**
Part A	CC1 - **Algebraic Structures**	5	7 (6/1/0)
	CC2 - **Real Analysis I**	5	7 (6/1/0)
	CC3 - **Ordinary Differential Equations**	4	6 (5/1/0)
	Elective I (Discipline Centric) (One from Group A)	3	5 (5/1/0)
	Elective II (Generic) (One from Group B)	3	5 (3/0/2)
	Total	**20**	**30**

	Semester-II	**Credit**	**Hours per week(L/T/P)**
Part A	CC4 – **Advanced Algebra**	5	6 (5/1/0)
	CC5 – **Real Analysis II**	5	6 (5/1/0)
	CC6 - **Partial Differential Equations**	4	6 (5/1/0)
	Elective III (Discipline Centric)(one from Group C)	3	4 (4/0/0)
	Elective-IV (Generic) (one from Group D)	3	4 (4/0/0)
Part B	NME I (one from NME list)	2	4 (4/0/0)
	Total	**22**	**30**

	Second Year - Semester-III	**Credit**	**Hours per week(L/T/P)**
Part A	CC7 - **Complex Analysis**	5	6 (5/1/0)
	CC8 - **Probability Theory**	5	6 (5/1/0)
	CC9 – **Topology**	5	6 (5/1/0)
	CC10 – **Mechanics**	4	5 (5/0/0)
	Elective V (Discipline Centric) (One from Group E)	3	4 (4/0/0)
Part B	NME II (another one from NME list)	2	3 (3/0/0)
	Internship / Industrial Activity (Carried out in Summer Vacation at the end of I year – 30 hours)	2	
	Total	**26**	**30**

	Semester-IV	**Credit**	**Hours per week (L/T/P)**
Part A	CC11–**Functional Analysis**	5	6 (5/1/0)
	CC12 - **Differential Geometry**	5	6 (5/1/0)
	Project with viva voce	7	10
	Elective VI (Industry / Entrepreneurship) **Advanced LaTex Practical**	3	4 (0/0/4)
Part B	Skill Enhancement Course / Professional Competency Skill Training for Competitive Examinations • Mathematics for NET / UGC - CSIR/ SET / TRB Competitive Examinations (2 hours) • General Studies for UPSC / TNPSC / Other Competitive Examinations (2 hours) OR Mathematics for Advanced Research Studies (4 hours)	2	4 (4/0/0)
Part C	Extension Activity	1	
	Total	**23**	**30**

TOTAL CREDITS: 91

Consolidated Table for Credits Distribution

	Category of Courses	Credits for each Course	Number of Courses	Number of Credits in each Category of Courses	Total Credits	Total Credits for the Programme
PART A	Core	5	9	45	86	86 (CGPA)
	Core	4	3	12		
	Project with viva voce	7	1	7		
	Electives (Generic / Discipline /Industry Centric)	3	6	18		
PART B (i)	NME	2	2	4		
PART B (ii)	Skill Enhancement (Term paper and Seminar & Generic / Discipline - Centric Skill Courses) (Internal Assessment Only)	2	1	2	5	5 (Non CGPA)
PART B (iii)	Summer Internship	1	2	2		
PART C	Extension Activity	1	1	1		
						91

Template for Semester

Code	Category	Title of the Paper	Marks (Max 100)		Duration for UE	Credits
			CIA	UE		
Semester –I						
Part A	Core I		25	75	3 Hrs	5
	Core II		25	75	3 Hrs	5
	Core III		25	75	3 Hrs	4
	Elective I Discipline Centric	Elective-I (Choose one from Group-A)	25	75	3 Hrs	3
	Elective II Generic	Elective-I I (Choose one from Group-B)	25	75	3 Hrs	3
Semester-II						
Part A	Core IV		25	75	3 Hrs	5
	Core V		25	75	3 Hrs	5
	Core VI		25	75	3 Hrs	4
	Elective III Discipline Centric	Elective-III (Choose one from Group-C)	25	75	3 Hrs	3
	Elective IV Generic	Elective-IV (Choose one from Group-D)	25	75	3 Hrs	3
Part B	NME I	Choose one from NME List	25	75	3 Hrs	2
Semester-III						
Part A	Core VII		25	75	3 Hrs	5
	Core VIII		25	75	3 Hrs	5
	Core IX		25	75	3 Hrs	5
	Core X		25	75	3 Hrs	4
	Elective V Discipline Centric	Elective-V (Choose one from Group-E)	25	75	3 Hrs	3

Part B	NME II	Choose another one from NME List	25	75	3 Hrs	2
Part B	Internship / Industrial - Vacation Activity	Internal Assessment Report 50 % and Viva voce 50%				2
Semester-IV						
Part A	Core X		25	75	3 Hrs	5
	Core XI		25	75	3 Hrs	5
	Project with viva voce		25	75	3 Hrs	7
	Elective VI (Industry Entrepreneurship)	Elective-VI Advanced Latex Practical	50	50	3 Hrs	3
Part B	Skill Enhancement Course	Professional Competency Skill	Internal Assessment Assignment of problem by the faculty Lecture -I (by the student) 25% Lecture-II (by the student) 25% Lecture-III (by the student) 25% Submission of a write-up (10-15 pages using LaTeX) 25% Marks / Grade Point/ Letter Grade as per the Regulation)			2
Part C	Extension Activity	Performance based assessment				1
					Total Credits	**91**

Elective Courses

Courses are grouped (Group A to Group E) so as to include topics from Pure Mathematics (PM), Applied Mathematics(AM), Industrial Components(IC) and IT Oriented(ITC) courses for flexibility of choice by the stakeholders / institutions.

Semester I : Elective I and Elective II

Elective I to be chosen from **Group A: (PM/AP/IC/ITC) Discipline Centric**

1. Number Theory and Cryptography
2. Graph Theory and Applications
3. Lie Groups and Lie Algebras
4. Rings and modules

Elective II to be chosen from **Group B:(PM/AP/IC/ITC) Generic**

1. Programming in C++ and Numerical Methods
2. Mathematical Programming
3. Fuzzy Sets and Their Applications
4. Formal Languages and Automata Theory
5. Programming in C++ with Practical (Second and Third Internal Assessment Tests are purely practical examinations. Teaching hours: 3T +2P)

Semester II : Elective III & Elective IV

Elective III to be chosen from **Group C :(PM/AP/IC/ITC) Discipline Centric**

1. Algebraic Topology
2. Mathematical Statistics
3. Wavelets
4. Tensor Analysis and Relativity
5. Advanced Graph Theory

Elective IV to be chosen from **Group D :(PM/AP/IC/ITC) Generic**

1. Statistical Data Analysis using R Programming
2. Modelling and Simulation with Excel

3. Machine Learning and Artificial Intelligence
4. Neural Networks
5. Financial Mathematics
6. Mathematical Python
7. Resource Management Techniques

Semester III : Elective V

Elective V to be chosen from **Group E: (PM/AP/IC/ITC) Discipline Centric**

1. Algebraic Number Theory
2. Fluid Dynamics
3. Stochastic Processes
4. Combinatorial Theory

Non Major Elective Courses (NME) Semesters II and III

1. Mathematics for Competitive Examinations
2. Discrete Mathematics
3. Numerical Methods
4. Mathematical Biology

Skill Enhancement Course / Professional Competency Skill
Semester IV

Training for Competitive Examinations

- Mathematics for NET / UGC - CSIR/ SET / TRB Competitive Examinations (2 hours)
- General Studies for UPSC / TNPSC / Other Competitive Examinations (2 hours)

(OR)

Mathematics for Advanced Research Studies (4 hours)

Instructions for Course Transaction

Courses	Lecture hrs	Tutorial hrs	Lab Practice	Total hrs
Core	75	15	--	90
Electives	60	15	--	75
NME	45	15	--	60
Lab Practice Courses	45	15	30	90
Project	20	--	70	90

Testing Pattern (25+75)

Internal Assessment

Theory Course: For theory courses there shall be three tests conducted by the faculty concerned and the average of the best two can be taken as the Continuous Internal Assessment (CIA) for a maximum of 25 marks. The duration of each test shall be one / one and a half hour.

Computer Laboratory Courses: For Computer Laboratory oriented Courses, there shall be two tests in Theory part and two tests in Laboratory part. Choose one best from Theory part and other best from the two Laboratory part. The average of the best two can be treated as the CIA for a maximum of 25 marks. The duration of each test shall be one / one and a half hour.

There is no improvement for CIA of both theory and laboratory, and, also for University End Semester Examination.

Written Examination : Theory Paper (Bloom's Taxonomy based)

Question paper Model

Intended Learning Skills	**Maximum 75 Marks** **Passing Minimum: 50%** **Duration : Three Hours**
	Part –A (10x 2 = 20 Marks) Answer ALL questions **Each Question carries 2mark**
Memory Recall / Example/ Counter Example / Knowledge about the Concepts/ Understanding	Two questions from each UNIT
	Question 1 to Question 10
	Part – B (5 x 5 = 25 Marks) **Answer ALL questions** **Each questions carries 5 Marks**
Descriptions/ Application (problems)	**Either-or Type** Both parts of each question from the same UNIT
	Question 11(a) or 11(b) To **Question 15(a) or 15(b)**
	Part-C (3x 10 = 30 Marks) **Answer any THREE questions** **Each question carries 10 Marks**
Analysis /Synthesis / Evaluation	There shall be FIVE questions covering all the five units
	Question 16 to Question 20

Each question should carry the course outcome and cognitive level

For instance,

1. [CO1 : K2] Question xxxx
2. [CO3 : K1] Question xxxx

Different Types of Courses

(i) Core Courses

1. Algebraic Structures
2. Real Analysis I
3. Ordinary Differential Equations
4. Advanced Algebra
5. Real Analysis II
6. Partial Differential Equations
7. Complex Analysis
8. Probability Theory
9. Topology
10. Mechanics
11. Functional Analysis
12. Differential Geometry

(ii) Elective Courses (ED within the Department Experts)

1. Number Theory and Cryptography
2. Graph Theory with Applications
3. Lie Groups and Lie Algebras
4. Rings and Modulus
5. Programming in C++ and Numerical Methods
6. Mathematical Programming
7. Fuzzy Sets and Their Applications
8. Formal Languages and Automata Theory
9. Programming in C++ with practical (Second and Third Internal Assessment Tests are purely practical examinations. Teaching hours: 3T +2P)
10. Algebraic Topology
11. Mathematical Statistics
12. Wavelets
13. Tensor Analysis and Relativity
14. Advanced Graph Theory
15. Statistical Data Analysis using R Programming
16. Modelling and Simulation with Excel
17. Machine Learning and Artificial Intelligence
18. Neural Networks
19. Financial Mathematics
20. Mathematical Python
21. Resource Management Techniques
22. Algebraic Number Theory
23. Fluid Dynamics
24. Stochastic Processes
25. Combinatorial Theory

(iii) Non Major Elective Courses (NME) Semesters II and III

1. **Mathematics for Competitive Examinations**
2. **Discrete Mathematics**
3. **Numerical Methods**
4. **Mathematical Biology**

(iv) Skill Enhancement Course / Professional Competency Skill

(v) Institution-Industry-Interaction (Industry aligned Courses)

Programmes /course work/ field study/ Modelling the Industry Problem/ Statistical Analysis / Commerce-Industry related problems / MoU with Industry and the like activities.

Syllabus for different Courses of M.Sc. Mathematics

Title of the Course		**ALGEBRAIC STRUCTURES**					
Paper Number		**CORE I**					
Category	Core	**Year**	I	**Credits**	5	**Course Code**	
		Semester	I				
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
		6	1	--	7		
Pre-requisite		UG level Modern Algebra					
Objectives of the Course		To introduce the concepts and to develop working knowledge on class equation, solvability of groups, finite abelian groups, linear transformations, real quadratic forms					
Course Outline		**UNIT-I :** Counting Principle - Class equation for finite groups and its applications - Sylow's theorems (For theorem 2.12.1, First proof only).**Chapter 2: Sections 2.11 and 2.12 (Omit Lemma 2.12.5)**					
		UNIT-II : Solvable groups - Direct products - Finite abelian groups- Modules **Chapter 5 : Section 5.7 (Lemma 5.7.1, Lemma 5.7.2, Theorem 5.7.1) Chapter 2: Section 2.13 and 2.14 (Theorem 2.14.1 only) Chapter 4: Section 4.5**					
		UNIT-III : Linear Transformations: Canonical forms –Triangular form - Nilpotent transformations **Chapter 6: Sections 6.4, 6.5**					
		UNIT-IV : Jordan form - rational canonical form. **Chapter 6 : Sections 6.6 and 6.7**					
		UNIT-V: Trace and transpose - Hermitian, unitary, normal transformations, real quadratic form. **Chapter 6 : Sections 6.8, 6.10 and 6.11 (Omit 6.9)**					
Extended Professional Component		Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)					
Skills acquired from this course		Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill					
Recommended Text		I.N. Herstein. *Topics in Algebra* (II Edition) Wiley Eastern Limited, New Delhi, 1975.					

Reference Books	1. M.Artin, Algebra, Prentice Hall of India, 1991. 2. P.B.Bhattacharya, S.K.Jain, and S.R.Nagpaul, Basic Abstract Algebra (II Edition) Cambridge University Press, 1997. (Indian Edition) 3. I.S.Luther and I.B.S.Passi, Algebra, Vol. I –Groups(1996); Vol. II Rings, Narosa Publishing House , New Delhi, 1999
	4. D.S.Malik, J.N. Mordeson and M.K.Sen, Fundamental of Abstract Algebra, McGraw Hill (International Edition), New York. 1997. 5. N.Jacobson, Basic Algebra, Vol. I & II W.H.Freeman (1980); also published by Hindustan Publishing Company, New Delhi.
Website and e-Learning Source	http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics, http://www.opensource.org, www.algebra.com

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO 1: Recall basic counting principle, define class equations to solve problems, explain Sylow's theorems and apply the theorem to find number of Sylow subgroups

CLO 2: Define Solvable groups, define direct products, examine the properties of finite abelian groups, define modules

CLO 3: Define similar Transformations, define invariant subspace, explore the properties of triangular matrix, to find the index of nilpotence to decompose a space into invariant subspaces, to find invariants of linear transformation, to explore the properties of nilpotent transformation relating nilpotence with invariants.

CLO 4: Define Jordan, canonical form, Jordan blocks, define rational canonical form, define companion matrix of polynomial, find the elementary devices of transformation, apply the concepts to find characteristic polynomial of linear transformation.

CLO 5: Define trace, define transpose of a matrix, explain the properties of trace and transpose, to find trace, to find transpose of matrix, to prove Jacobson lemma using the triangular form, define symmetric matrix, skew symmetric matrix, adjoint, to define Hermitian, unitary, normal transformations and to verify whether the transformation in Hermitian, unitary and normal.

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CLO 1	3	3	2	3	3	2	3	3	2	3
CLO 2	3	2	2	3	2	2	2	1	2	2
CLO 3	3	2	2	3	2	1	2	2	2	3
CLO 4	3	2	2	3	2	2	2	2	2	2
CLO 5	3	3	2	3	2	3	3	3	2	3

CLO-PO-PSO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO 1	3	3	3	3	2	3	2	3	1	2
CLO 2	3	2	2	2	2	3	2	3	1	2
CLO 3	3	3	2	2	2	3	2	3	1	3
CLO 4	3	3	2	2	2	3	2	3	1	3
CLO 5	3	3	3	3	3	3	2	3	1	2

Level of correlation: 3-High, **2**-Medium, **1**-Low

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">REAL ANALYSIS I</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">CORE II</td></tr>
<tr><td>Category</td><td>Core</td><td>Year</td><td>I</td><td>Credits</td><td>5</td><td>Course Code</td><td></td></tr>
<tr><td colspan="2"></td><td>Semester</td><td>I</td><td colspan="4"></td></tr>
<tr><td colspan="2">Instructional Hours per week</td><td colspan="2">Lecture
6</td><td colspan="2">Tutorial
1</td><td>Lab Practice
--</td><td>Total
7</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">UG level real analysis concepts</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">To work comfortably with functions of bounded variation, Riemann-Stieltjes Integration, convergence of infinite series, infinite product and uniform convergence and its interplay between various limiting operations.</td></tr>
<tr><td colspan="2" rowspan="2">Course Outline</td><td colspan="6">UNIT-I : Functions of bounded variation - Introduction - Properties of monotonic functions - Functions of bounded variation - Total variation - Additive property of total variation - Total variation on [a, x] as a function of x - Functions of bounded variation expressed as the difference of two increasing functions - Continuous functions of bounded variation.
Chapter – 6 : Sections 6.1 to 6.8
Infinite Series : Absolute and conditional convergence - Dirichlet's test and Abel's test - Rearrangement of series - Riemann's theorem on conditionally convergent series.
Chapter 8 : Sections 8.8, 8.15, 8.17, 8.18</td></tr>
<tr><td colspan="6">UNIT-II : The Riemann - Stieltjes Integral - Introduction - Notation - The definition of the Riemann - Stieltjes integral - Linear Properties - Integration by parts- Change of variable in a Riemann - Stieltjes integral - Reduction to a Riemann Integral – Euler’s summation formula - Monotonically increasing integrators, Upper and lower integrals - Additive and linearity properties of upper, lower integrals - Riemann's condition - Comparison theorems.
Chapter - 7 : Sections 7.1 to 7.14</td></tr>
</table>

	UNIT-III : The Riemann-Stieltjes Integral - Integrators of bounded variation-Sufficient conditions for the existence of Riemann-Stieltjes integrals-Necessary conditions for the existence of RS integrals- Mean value theorems -integrals as a function of the interval – Second fundamental theorem of integral calculus-Change of variable -Second Mean Value Theorem for Riemann integral- Riemann-Stieltjes integrals depending on a parameter- Differentiation under integral sign-Lebesgue criteriaon for existence of Riemann integrals. Chapter - 7 : 7.15 to 7.26
	UNIT-IV : Infinite Series and infinite Products - Double sequences - Double series - Rearrangement theorem for double series - A sufficient condition for equality of iterated series - Multiplication of series – Cesaro summability - Infinite products. **Chapter - 8 Sec, 8.20, 8.21 to 8.26** **Power series** - Multiplication of power series - The Taylor's series generated by a function - Bernstein's theorem - Abel's limit theorem - Tauber's theorem **Chapter 9 : Sections 9.14 9.15, 9.19, 9.20, 9.22, 9.23**
	UNIT-V: Sequences of Functions – Pointwise convergence of sequences of functions - Examples of sequences of real - valued functions - Uniform convergence and continuity - Cauchy condition for uniform convergence - Uniform convergence of infinite series of functions - Riemann - Stieltjes integration – Non-uniform Convergence and Term-by-term Integration - Uniform convergence and differentiation - Sufficient condition for uniform convergence of a series - Mean convergence. **Chapter -9 Sec 9.1 to 9.6, 9.8,9.9,9.10,9.11, 9.13**
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	Tom M.Apostol : *Mathematical Analysis*, 2nd Edition, Addison-Wesley Publishing Company Inc. New York, 1974.

Reference Books	1. Bartle, R.G. *Real Analysis*, John Wiley and Sons Inc., 1976. 2. Rudin,W. *Principles of Mathematical Analysis*, 3rd Edition. McGraw Hill Company, New York, 1976. 3. Malik,S.C. and Savita Arora. *Mathematical Anslysis*, Wiley Eastern Limited.New Delhi, 1991. 4. Sanjay Arora and Bansi Lal, *Introduction to Real Analysis*, Satya Prakashan, New Delhi, 1991. 5. Gelbaum, B.R. and J. Olmsted, *Counter Examples in Analysis*, Holden day, San Francisco, 1964. 6. A.L.Gupta and N.R.Gupta, *Principles of Real Analysis*, Pearson Education, (Indian print) 2003.
Website and e-Learning Source	http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics, http://www.opensource.org, www.mathpages.com

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO1: Analyze and evaluate functions of bounded variation and Rectifiable Curves.

CLO2: Describe the concept of Riemann-Stieltjes integral and its properties.

CLO3: Demonstrate the concept of step function, upper function, Lebesgue function and their integrals.

CLO4: Construct various mathematical proofs using the properties of Lebesgue integrals and establish the Levi monotone convergence theorem.

CLO5: Formulate the concept and properties of inner products, norms and measurable functions.

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**
CLO 1	3	3	2	3	3	2	3	3	2	3
CLO 2	3	2	2	3	2	2	2	1	2	2
CLO 3	3	2	2	3	2	1	2	2	2	3
CLO 4	3	2	2	3	2	3	3	3	3	3
CLO 5	3	3	2	3	2	3	3	3	3	-

CLO-PO-PSO Mapping

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CLO 1	3	3	3	3	2	3	2	3	1	2
CLO 2	3	2	2	2	2	3	2	3	1	2
CLO 3	3	2	2	2	2	2	2	2	2	2
CLO 4	3	3	2	2	2	3	2	3	1	3
CLO 5	3	3	3	3	3	3	2	3	1	2

Level of correlation: 3-High, **2**-Medium, **1**-Low

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">ORDINARY DIFFERENTIAL EQUATIONS</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">CORE III</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">4</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>I</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td colspan="2">Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td colspan="2">5</td><td colspan="2">1</td><td colspan="2">--</td><td>6</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="8">UG level Calculus and Differential Equations</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="8">To develop strong background on finding solutions to linear differential equations with constant and variable coefficients and also with singular points, to study existence and uniqueness of the solutions of first order differential equations</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="8">UNIT-I : Linear equations with constant coefficients
Second order homogeneous equations-Initial value problems-Linear dependence and independence-Wronskian and a formula for Wronskian-Non-homogeneous equation of order two.
Chapter 2: Sections 1 to 6</td></tr>
<tr><td colspan="8">UNIT-II : Linear equations with constant coefficients
Homogeneous and non-homogeneous equation of order n –Initial value problems- Annihilator method to solve non-homogeneous equation-Algebra of constant coefficient operators.
Chapter 2 : Sections 7 to 12.</td></tr>
<tr><td colspan="8">UNIT-III : Linear equation with variable coefficients
Initial value problems -Existence and uniqueness theorems – Solutions to solve a non-homogeneous equation – Wronskian and linear dependence – reduction of the order of a homogeneous equation – homogeneous equation with analytic coefficients-The Legendre equation.
Chapter : 3 Sections 1 to 8 (Omit section 9)</td></tr>
<tr><td colspan="8">UNIT-IV :Linear equation with regular singular points
Euler equation – Second order equations with regular singular points – Exceptional cases – Bessel Function.
Chapter 4 : Sections 1 to 4 and 6 to 8 (Omit sections 5 and 9)</td></tr>
<tr><td colspan="8">UNIT-V : Existence and uniqueness of solutions to first order equations: Equation with variable separated – Exact equation – method of successive approximations – the Lipschitz condition – convergence of the successive approximations and the existence theorem.
Chapter 5 : Sections 1 to 6 (Omit Sections 7 to 9)</td></tr>
</table>

Extended Professional Component	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	E.A.Coddington, *A introduction to ordinary differential equations* (3rd Printing) Prentice-Hall of India Ltd., New Delhi, 1987.
Reference Books	1. Williams E. Boyce and Richard C. DI Prima, *Elementary differential equations and boundary value problems*, John Wiley and sons, New York, 1967. 2. George F Simmons, *Differential equations with applications and historical notes,* Tata McGraw Hill, New Delhi, 1974. 3. N.N. Lebedev, *Special functions and their applications*, Prentice Hall of India, New Delhi, 1965. 4. W.T. Reid. *Ordinary Differential Equations*, John Wiley and Sons, New York, 1971 5. M.D.Raisinghania, *Advanced Differential Equations*, S.Chand & Company Ltd. New Delhi 2001 6. B.Rai, D.P.Choudary and H.I. Freedman, *A Course in Ordinary Differential Equations,* Narosa Publishing House, New Delhi, 2002.
Website and e-Learning Source	http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics, http://www.opensource.org, www.mathpages.com

Course Learning Outcome (for Mapping with POs and PSOs); Students will be able to

CLO1: Establish the qualitative behavior of solutions of systems of differential equations .

CLO2: Recognize the physical phenomena modeled by differential equations and dynamical systems.

CLO3: Analyze solutions using appropriate methods and give examples.

CLO4: Formulate Green's function for boundary value problems.

CLO5: Understand and use various theoretical ideas and results that underlie the mathematics in this course.

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**
CLO 1	3	3	2	3	3	2	3	3	2	3
CLO 2	2	3	2	3	2	2	2	1	2	2
CLO 3	2	3	2	3	2	1	2	2	2	3
CLO 4	2	3	2	3	2	2	2	2	2	2
CLO 5	3	3	2	3	2	3	3	3	2	3

CLO-PO-PSO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO 1	3	3	3	3	3	3	2	3	1	2
CLO 2	3	3	3	3	3	3	2	3	1	2
CLO 3	3	3	2	2	2	3	2	3	1	3
CLO 4	3	3	2	2	2	3	2	3	1	3
CLO 5	3	3	3	3	3	3	2	3	1	2

Level of correlation: 3-High, **2**-Medium, **1**-Low

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">ADVANCED ALGEBRA</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">CORE IV</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">5</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>II</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td colspan="2">Lecture</td><td colspan="2">Tutorial</td><td>Lab Practice</td><td>Total</td></tr>
<tr><td colspan="2">5</td><td colspan="2">1</td><td>--</td><td>6</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">Algebraic Structures</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">To study field extension, roots of polynomials, Galois Theory, finite fields, division rings, solvability by radicals and to develop computational skill in abstract algebra.</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="6">UNIT-I :Extension fields – Transcendence of e.
Chapter 5: Section 5.1 and 5.2</td></tr>
<tr><td colspan="6">UNIT-II : Roots or Polynomials.- More about roots
Chapter 5: Sections 5.3 and 5.5</td></tr>
<tr><td colspan="6">UNIT-III : Elements of Galois theory.
Chapter 5 : Section 5.6</td></tr>
<tr><td colspan="6">UNIT-IV : Finite fields - Wedderburn's theorem on finite division rings.
Chapter 7: Sections 7.1 and 7.2 (Theorem 7.2.1 only)</td></tr>
<tr><td colspan="6">UNIT-V :Solvability by radicals - A theorem of Frobenius - Integral Quaternions and the Four - Square theorem.
Chapter 5: Section 5.7 (omit Lemma 5.7.1, Lemma 5.7.2 and Theorem 5.7.1)
Chapter 7 : Sections 7.3 and 7.4</td></tr>
</table>

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	I.N. Herstein. *Topics in Algebra* (II Edition) Wiley EasternLimited, New Delhi, 1975.
Reference Books	1. M.Artin, *Algebra,* Prentice Hall of India, 1991. 2. P.B.Bhattacharya, S.K.Jain, and S.R.Nagpaul, *Basic Abstract Algebra* (II Edition) Cambridge University Press, 1997. (Indian Edition) 3. I.S.Luther and I.B.S.Passi, *Algebra,* Vol. I –Groups(1996); Vol. II *Rings,*Narosa Publishing House , New Delhi, 1999 4. D.S.Malik, J.N. Mordeson and M.K.Sen, *Fundamental of Abstract Algebra*, McGraw Hill (International Edition), New York. 1997. 5. N.Jacobson, *Basic Algebra,* Vol. I & II Hindustan Publishing Company, New Delhi.
Website and e-Learning Source	http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics, http://www.opensource.org, www.algebra.com

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO1: Prove theorems applying algebraic ways of thinking.

CLO2: Connect groups with graphs and understanding about Hamiltonian graphs.

CLO3: Compose clear and accurate proofs using the concepts of Galois Theory.

CLO4: Bring out insight into Abstract Algebra with focus on axiomatic theories.

CLO5: Demonstrate knowledge and understanding of fundamental concepts including extension fields, Algebraic extensions, Finite fields, Class equations and Sylow's theorem.

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CLO 1	3	3	2	3	3	2	3	3	2	3
CLO 2	2	3	2	3	2	2	2	1	2	2
CLO 3	2	3	2	3	2	1	2	2	2	3
CLO 4	2	3	2	1	2	3	2	2	2	2
CLO 5	3	3	2	3	2	1	3	3	2	3

CLO-PO-PSO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO 1	3	3	3	3	3	3	2	3	3	-
CLO 2	3	3	3	3	3	3	2	3	3	-
CLO 3	3	3	2	2	2	3	2	3	3	-
CLO 4	3	3	2	2	2	3	2	3	3	-
CLO 5	3	3	3	3	3	3	2	3	3	-

Level of correlation: 3-High, **2**-Medium, **1**-Low

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">REAL ANALYSIS II</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">CORE V</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">5</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>II</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td colspan="2">Lecture</td><td colspan="2">Tutorial</td><td>Lab Practice</td><td>Total</td></tr>
<tr><td colspan="2">5</td><td colspan="2">1</td><td>--</td><td>6</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">Elements of Real Analysis</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">To introduce measure on the real line, Lebesgue measurability and integrability, Fourier Series and Integrals, in-depth study in multivariable calculus.</td></tr>
<tr><td colspan="2" rowspan="2">Course Outline</td><td colspan="6">UNIT-I :Measure on the Real line - Lebesgue Outer Measure - Measurable sets - Regularity - Measurable Functions - Borel and Lebesgue Measurability
Chapter - 2 Sec 2.1 to 2.5 (de Barra)</td></tr>
<tr><td colspan="6">UNIT-II : Integration of Functions of a Real variable - Integration of Non- negative functions - The General Integral - Riemann and Lebesgue Integrals
Chapter - 3 Sec 3.1,3.2 and 3.4 (de Barra)</td></tr>
</table>

	UNIT-III : Fourier Series and Fourier Integrals - Introduction - Orthogonal system of functions - The theorem on best approximation - The Fourier series of a function relative to an orthonormal system - Properties of Fourier Coefficients - The Riesz-Fischer Thorem - The convergence and representation problems in for trigonometric series - The Riemann - Lebesgue Lemma - The Dirichlet Integrals - An integral representation for the partial sums of Fourier series - Riemann's localization theorem - Sufficient conditions for convergence of a Fourier series at a particular point –Cesarosummability of Fourier series- Consequences of Fejes's theorem - The Weierstrass approximation theorem **Chapter 11 : Sections 11.1 to 11.15 (Apostol)**
	UNIT-IV : Multivariable Differential Calculus - Introduction - The Directional derivative - Directional derivative and continuity - The total derivative - The total derivative expressed in terms of partial derivatives - The matrix of linear function - The Jacobian matrix - The chain rule - Matrix form of chain rule - The mean - value theorem for differentiable functions - A sufficient condition for differentiability - A sufficient condition for equality of mixed partial derivatives - Taylor's theorem for functions of R^n to R^1 **Chapter 12 : Section 12.1 to 12.14 (Apostol)**
	UNIT-V : Implicit Functions and Extremum Problems : Functions with non-zero Jacobian determinants – The inverse function theorem- The Implicit function theorem-Extrema of real valued functions of severable variables-Extremum problems with side conditions. **Chapter 13 : Sections 13.1 to 13.7 (Apostol)**
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Recommended Text	1. G. de Barra, *Measure Theory and Integration*, Wiley Eastern Ltd., New Delhi, 1981. (for Units I and II) 2. Tom M.Apostol : *Mathematical Analysis*, 2nd Edition, Addison-Wesley Publishing Company Inc. New York, 1974. (for Units III, IV and V)
Reference Books	1. Burkill,J.C.*The Lebesgue Integral*, Cambridge University Press, 1951. 2. Munroe,M.E.*Measure and Integration*. Addison-Wesley, Mass.1971. 3. Roydon,H.L.*Real Analysis*, Macmillan Pub. Company, New York, 1988. 4. Rudin, W. *Principles of Mathematical Analysis*, McGraw Hill Company, New York,1979. 5. Malik,S.C. and Savita Arora. *Mathematical Analysis,* Wiley Eastern Limited. New Delhi, 1991. 6. Sanjay Arora and Bansi Lal, *Introduction to Real Analysis*, Satya Prakashan, New Delhi, 1991
Website and e-Learning Source	http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics, http://www.opensource.org

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO1: Understand and describe the basic concepts of Fourier series and Fourier integrals with respect to orthogonal system.

CLO2: Analyze the representation and convergence problems of Fourier series.

CLO3: Analyze and evaluate the difference between transforms of various functions.

CLO4: Formulate and evaluate complex contour integrals directly and by the fundamental theorem.

CLO5: Apply the Cauchy integral theorem in its various versions to compute contour integration.

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**
CLO 1	3	3	2	3	3	2	3	3	2	3
CLO 2	2	3	2	3	2	2	2	1	2	2
CLO 3	2	3	2	3	2	1	2	2	2	3
CLO 4	3	3	3	3	3	3	2	2	2	2
CLO 5	2	1	1	1	1	2	3	3	2	3

CLO-PO-PSO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO 1	3	3	3	3	-	3	2	3	3	2
CLO 2	3	3	3	3	1	3	2	3	3	2
CLO 3	3	3	2	2	1	3	2	3	3	2
CLO 4	3	3	2	2	1	3	2	3	3	2
CLO 5	3	3	3	3	-	3	2	3	3	2

Level of correlation: 3-High, **2**-Medium, **1**-Low

Title of the Course	**PARTIAL DIFFERENTIAL EQUATIONS**					
Paper Number	**CORE VI**					
Category Core	**Year**	I	**Credits**	4	**Course Code**	
	Semester	II				
Instructional Hours per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
	5	1	--	6		
Pre-requisite	UG level partial differential equations					
Objectives of the Course	To classify the second order partial differential equations and to study Cauchy problem, method of separation of variables, boundary value problems.					
Course Outline	**UNIT-I :Mathematical Models and Classification of second order equation :** Classical equations-Vibrating string – Vibrating membrane – waves in elastic medium – Conduction of heat in solids – Gravitational potential – Second order equations in two independent variables – canonical forms – equations with constant coefficients – general solution **Chapter 2 : Sections 2.1 to 2.6** **Chapter 3 : Sections 3.1 to 3.4 (Omit 3.5)**					
	UNIT-II :Cauchy Problem : The Cauchy problem – Cauchy-Kowalewsky theorem – Homogeneous wave equation – Initial Boundary value problem- Non-homogeneous boundary conditions – Finite string with fixed ends – Non-homogeneous wave equation – Riemann method – Goursat problem – spherical wave equation – cylindrical wave equation.**Chapter 4 : Sections 4.1 to 4.11**					
	UNIT-III :Method of separation of variables: Separation of variable-Vibrating string problem – Existence and uniqueness of solution of vibrating string problem - Heat conduction problem – Existence and uniqueness of solution of heat conduction problem – Laplace and beam equations **Chapter 6 : Sections 6.1 to 6.6 (Omit section 6.7)**					

	UNIT-IV : Boundary Value Problems : Boundary value problems – Maximum and minimum principles – Uniqueness and continuity theorem – Dirichlet Problem for a circle , a circular annulus, a rectangle – Dirichlet problem involving Poisson equation – Neumann problem for a circle and a rectangle. **Chapter 8 : Sections 8.1 to 8.9**
	UNIT-V : Green's Function: The Delta function – Green's function – Method of Green's function – Dirichlet Problem for the Laplace and Helmholtz operators – Method of images and eigen functions – Higher dimensional problem – Neumann Problem. **Chapter 10 : Section 10.1 to 10.9**
Extended Professional Component	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	TynMyint-U and Lokenath Debnath, *Partial Differential Equations for Scientists and Engineers* (Third Edition), North Hollan, New York, 1987.
Reference Books	1. M.M.Smirnov, *Second Order partial Differential Equations*, Leningrad, 1964. 2. I.N.Sneddon, *Elements of Partial Differential Equations,* McGraw Hill, New Delhi, 1983. 3. R. Dennemeyer, *Introduction to Partial Differential Equations and Boundary Value Problems,* McGraw Hill, New York, 1968. 4. M.D.Raisinghania, *Advanced Differential Equations,* S.Chand & Company Ltd., New Delhi, 2001. 5. S, Sankar Rao, *Partial Differential Equations*, 2nd Edition, Prentice Hall of India, New Delhi. 2004
Website and e-Learning Source	http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics, http://www.opensource.org, www.mathpages.com

Course Learning Outcome (for Mapping with POs and PSOs) Students will be able to

CLO1: To understand and classify second order equations and find general solutions

CLO2: To analyse and solve wave equations in different polar coordinates

CLO3: To solve Vibrating string problem, Heat conduction problem, to identify and solve Laplace and beam equations

CLO4: To apply maximum and minimum principle's and solve Dirichlet, Neumann problems for various boundary conditions

CLO5: To apply Green's function and solve Dirichlet, Laplace problems, to apply Helmholtz operation and to solve Higher dimensional problem.

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CLO 1	3	3	2	3	3	2	3	3	2	3
CLO 2	2	3	2	3	2	2	2	1	2	2
CLO 3	2	3	2	3	2	1	2	2	2	3
CLO 4	3	3	3	3	3	3	3	3	3	3
CLO 5	2	1	1	1	1	2	3	3	2	3

CLO-PO-PSO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO 1	3	3	3	3	3	2	1	3	3	2
CLO 2	3	3	3	3	3	2	1	3	3	2
CLO 3	3	3	2	2	3	2	1	3	3	2
CLO 4	3	3	2	2	3	2	1	3	3	2
CLO 5	3	3	3	3	3	2	1	3	3	2

Level of correlation: 3-High, **2**-Medium, **1**-Low

Title of the Course	**COMPLEX ANALYSIS**						
Paper Number	**CORE VII**						
Category Core	**Year**	II	**Credits**	5	**Course Code**		
	Semester	III					
Instructional Hours per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**			
	5	1	--	6			
Pre-requisite	UG level Complex Analysis						
Objectives of the Course	To Study Cauchy integral formula, local properties of analytic functions, general form of Cauchy's theorem and evaluation of definite integral and harmonic functions						
Course Outline	**UNIT-I : Cauchy's Integral Formula:** The Index of a point with respect to a closed curve – The Integral formula – Higher derivatives. Local Properties of analytical Functions: Removable Singularities-Taylors's Theorem – Zeros and poles – The local Mapping – The Maximum Principle. **Chapter 4 : Section 2 : 2.1 to 2.3** **Chapter 4 : Section 3 : 3.1 to 3.4**						

	UNIT-II :The general form of Cauchy's Theorem : Chains and cycles- Simple Continuity - Homology - The General statement of Cauchy's Theorem - Proof of Cauchy's theorem - Locally exact differentials- Multiply connected regions - Residue theorem - The argument principle. **Chapter 4 : Section 4 : 4.1 to 4.7** **Chapter 4 : Section 5: 5.1 and 5.2**
	UNIT-III :Evaluation of Definite Integrals and Harmonic Functions Evaluation of definite integrals - Definition of Harmonic function and basic properties - Mean value property - Poisson formula. **Chapter 4 : Section 5 : 5.3** **Chapter 4 : Sections 6 : 6.1 to 6.3**
	UNIT-IV :Harmonic Functions and Power Series Expansions: Schwarz theorem - The reflection principle - Weierstrass theorem – Taylor's Series – Laurent series . **Chapter 4 : Sections 6.4 and 6.5** **Chapter 5 : Sections 1.1 to 1.3**
	UNIT-V: Partial Fractions and Entire Functions: Partial fractions - Infinite products – Canonical products – Gamma Function- Jensen's formula – Hadamard's Theorem **Chapter 5 : Sections 2.1 to 2.4** **Chapter 5 : Sections 3.1 and 3.2**
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	Lars V. Ahlfors, *Complex Analysis*, (3rd edition) McGraw Hill Co., New York, 1979

Reference Books	1. H.A. Presfly, *Introduction to complex Analysis*, Clarendon Press, oxford, 1990. 2. J.B. Conway, *Functions of one complex variables* Springer - Verlag, International student Edition, Naroser Publishing Co.1978 3. E. Hille, *Analytic function Thorey* (2 vols.), Gonm& Co, 1959. 4. M.Heins, *Complex function Theory*, Academic Press, New York,1968.
Website and e-Learning Source	http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics, http://www.opensource.org , http://en.wikipedia.org

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO1: Analyze and evaluate local properties of analytical functions and definite integrals.

CLO2: Describe the concept of definite integral and harmonic functions.

CLO3: Demonstrate the concept of the general form of Cauchy's theorem

CLO4: Develop Taylor and Laurent series .

CLO5 Explain the infinite products, canonical products and jensen's formula .

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**
CLO 1	3	3	3	3	3	2	3	3	2	3
CLO 2	2	3	3	3	2	2	2	1	2	2
CLO 3	2	3	3	3	2	1	2	2	2	3
CLO 4	3	3	3	3	3	3	3	3	3	3
CLO 5	2	3	3	1	1	2	3	3	2	3

CLO-PO-PSO Mapping

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CLO 1	3	3	3	3	3	2	-	3	3	2
CLO 2	3	3	3	3	3	2	-	3	3	2
CLO 3	3	3	2	2	3	2	-	3	3	2
CLO 4	3	3	2	2	3	2	-	3	3	2
CLO 5	3	3	3	3	3	2	-	3	3	2

Level of correlation: 3-High, **2**-Medium, **1**-Low

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">PROBABILITY THEORY</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">CORE VIII</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">5</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>III</td></tr>
<tr><td colspan="2">Instructional Hours per week</td><td colspan="2">Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td colspan="2"></td><td colspan="2">5</td><td colspan="2">1</td><td colspan="2">--</td><td>6</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="8">UG level algebra and calculus</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="8">To introduce axiomatic approach to probability theory, to study some statistical characteristics, discrete and continuous distribution functions and their properties, characteristic function and basic limit theorems of probability.</td></tr>
<tr><td colspan="2">Course Outline</td><td colspan="8">UNIT-I : Random Events and Random Variables: Random events – Probability axioms – Combinatorial formulae – conditional probability – Bayes Theorem – Independent events – Random Variables – Distribution Function – Joint Distribution – Marginal Distribution – Conditional Distribution – Independent random variables – Functions of random variables.
Chapter 1: Sections 1.1 to 1.7
Chapter 2 : Sections 2.1 to 2.9</td></tr>
<tr><td colspan="2"></td><td colspan="8">UNIT-II : Parameters of the Distribution : Expectation- Moments – The Chebyshev Inequality – Absolute moments – Order parameters – Moments of random vectors – Regression of the first and second types.
Chapter 3 : Sections 3.1 to 3.8</td></tr>
<tr><td colspan="2"></td><td colspan="8">UNIT-III: Characteristic functions : Properties of characteristic functions – Characteristic functions and moments – semi0invariants – characteristic function of the sum of the independent random variables – Determination of distribution function by the Characteristic function – Characteristic function of multidimensional random vectors – Probability generating functions.
Chapter 4 : Sections 4.1 to 4.7</td></tr>
<tr><td colspan="2"></td><td colspan="8">UNIT-IV : Some Probability distributions: One point , two point , Binomial – Polya – Hypergeometric – Poisson (discrete) distributions – Uniform – normal gamma – Beta – Cauchy and Laplace (continuous) distributions.
Chapter 5 : Section 5.1 to 5.10 (Omit Section 5.11)</td></tr>
<tr><td colspan="2"></td><td colspan="8">UNIT-V: Limit Theorems : Stochastic convergence – Bernaulli law of large numbers – Convergence of sequence of distribution functions – Levy-Cramer Theorems – de Moivre-Laplace Theorem – Poisson, Chebyshev, Khintchine Weak law of large numbers – Lindberg Theorem – Lapunov Theroem – Borel-Cantelli Lemma - Kolmogorov Inequality and Kolmogorov Strong Law of large numbers.
Chapter 6 : Sections 6.1 to 6.4, 6.6 to 6.9 , 6.11 and 6.12. (Omit Sections 6.5, 6.10,6.13 to 6.15)</td></tr>
</table>

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	M. Fisz, *Probability Theory and Mathematical Statistics,* John Wiley and Sons, New York, 1963.
Reference Books	1. R.B. Ash, *Real Analysis and Probability*, Academic Press, New York, 1972 2. K.L.Chung, *A course in Probability*, Academic Press, New York, 1974. 4. R.Durrett, *Probability : Theory and Examples*, (2nd Edition) Duxbury Press, New York, 1996. 5. V.K.Rohatgi*An Introduction to Probability Theory and Mathematical Statistics*, Wiley Eastern Ltd., New Delhi, 1988(3rd Print). 6. S.I.Resnick, *A Probability Path*, Birhauser, Berlin,1999. 7. B.R.Bhat , *Modern Probability Theory* (3rd Edition), New Age International (P)Ltd, New Delhi, 1999
Website and e-Learning Source	http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics, http://www.opensource.org, http://www.probability.net

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO1: To define Random Events, Random Variables, to describe Probability, to apply Bayes, to define Distribution Function, to find Joint Distribution function, to find Marginal Distribution and Conditional Distribution function, to solve functions on random variables.

CLO2: To define Expectation, Moments and Chebyshev Inequality, to solve Regression of the first and second types.

CLO3: To define Characteristic functions, to define distribution function, to find probability generating functions, to solve problems applying characteristic functions

CLO4: To define One point, two-point, Binomial distributions, to solve problems of Hypergeometric and Poisson distributions, to define Uniform, normal, gamma, Beta distributions, to solve problems on Cauchy and Laplace distributions

CLO5: To discuss Stochastic convergence, Bernaulli law of large numbers, to elaborate Convergence of sequence of distribution functions, to prove Levy-Cramer Theorems and de Moivre-Laplace Theorems, to explain Poisson, Chebyshev, Khintchine Weak law of large numbers, to explain and solve problems on Kolmogorov Inequality and Kolmogorov Strong Law of large numbers.

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CLO 1	3	3	3	3	3	2	3	3	2	3
CLO 2	2	3	3	3	2	2	2	1	2	2
CLO 3	2	3	3	3	2	1	2	2	2	3
CLO 4	3	3	3	3	3	3	3	3	3	3
CLO 5	2	3	3	1	1	2	3	3	2	3

CLO-PO-PSO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO 1	3	3	3	3	3	2	-	3	3	2
CLO 2	3	3	3	3	3	2	-	3	3	2
CLO 3	3	3	2	2	3	2	-	3	3	2
CLO 4	3	3	2	2	3	2	-	3	3	2
CLO 5	3	3	3	3	3	2	-	3	3	2

Level of correlation: 3-High, **2**-Medium, **1**-Low

Title of the Course		**TOPOLOGY**					
Paper Number		**CORE IX**					
Category	Core	**Year**	II	**Credits**	5	**Course Code**	
		Semester	III				
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
		5	1	--	6		
Pre-requisite		Real Analysis					
Objectives of the Course		To study topological spaces, continuous functions, connectedness, compactness, countability and separation axioms.					
Course Outline		**UNIT-I : Topological spaces :** Topological spaces – Basis for a topology – The order topology – The product topology on X × Y – The subspace topology – Closed sets and limit points. **Chapter 2 : Sections 12 to 17**					

	UNIT-II :Continuous functions: Continuous functions – the product topology – The metric topology. **Chapter 2 : Sections 18 to 21 (Omit Section 22)**
	UNIT-III :Connectedness: Connected spaces- connected subspaces of the Real line – Components and local connectedness. **Chapter 3 : Sections 23 to 25.**
	UNIT-IV : Compactness : Compact spaces – compact subspaces of the Real line – Limit Point Compactness – Local Compactness. **Chapter 3 : Sections 26 to 29.**
	UNIT-V: Countability and Separation Axiom: The Countability Axioms – The separation Axioms – Normal spaces – The Urysohn Lemma – The Urysohnmetrization Theorem – The Tietz extension theorem. **Chapter 4 : Sections 30 to 35.**
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	James R. Munkres, *Topology* (2nd Edition) Pearson Education Pve. Ltd., Delhi-2002 (Third Indian Reprint)
Reference Books	1. J. Dugundji ,*Topology* , Prentice Hall of India, New Delhi, 1975. 2. George F.Sinmons, *Introduction to Topology and Modern Analysis*, McGraw Hill Book Co., 1963 3. J.L. Kelly, *General Topology*, Van Nostrand, Reinhold Co., New York 4. L.Steen and J.Subhash, Counter Examples in Topology, Holt, Rinehart and Winston, New York, 1970. 5. S.Willard, *General Topology*, Addison - Wesley, Mass., 1970
Website and e-Learning Source	http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics, http://www.opensource.org , http://en.wikipedia.org

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO1: Define and illustrate the concept of topological spaces and the basic definitions of open sets, neighbourhood, interior, exterior, closure and their axioms for defining topological space.

CLO2: Understand continuity, compactness, connectedness, homeomorphism and topological properties.

CLO3: Analyze and apply the topological concepts in Functional Analysis.

CLO4: Ability to determine that a given point in a topological space is either a limit point or not for a given subset of a topological space.

CLO5: Develop qualitative tools to characterize connectedness, compactness, second countable, Hausdorff and develop tools to identify when two are equivalent(homeomorphic).

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CLO 1	3	3	3	3	3	2	3	3	2	3
CLO 2	2	3	3	3	2	2	2	1	2	2
CLO 3	2	3	3	3	2	1	2	2	2	3
CLO 4	3	3	3	3	3	3	3	3	3	3
CLO 5	2	3	3	1	1	2	3	3	2	3

CLO-PO-PSO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO 1	3	3	3	3	3	2	1	3	3	2
CLO 2	3	3	3	3	3	2	1	3	3	2
CLO 3	2	2	2	2	2	2	1	2	2	2
CLO 4	3	3	2	2	3	2	1	3	3	2
CLO 5	3	3	3	3	3	2	1	3	3	2

Level of correlation: 3-High, **2**-Medium, **1**-Low

Title of the Course		**MECHANICS**					
Paper Number		**CORE X**					
Category	Core	**Year**	II	**Credits**	4	**Course Code**	
		Semester	III				
Instructional Hours per week		**Lecture**		**Tutorial**	**Lab Practice**	**Total**	
		4		0	--	4	

Pre-requisite	UG level Calculus and Differential equations.
Objectives of the Course	To study mechanical systems under generalized coordinate systems, virtual work, energy and momentum, to study mechanics developed by Newton, Langrange, Hamilton Jacobi and Theory of Relativity due to Einstein.
Course Outline	**UNIT-I :** Mechanical Systems : The Mechanical system- Generalised coordinates – Constraints - Virtual work - Energy and Momentum **Chapter 1 : Sections 1.1 to 1.5**
	UNIT-II : Lagrange's Equations: Derivation of Lagrange's equations- Examples- Integrals of motion. **Chapter 2 : Sections 2.1 to 2.3 (Omit Section 2.4)**
	UNIT-III : Hamilton's Equations : Hamilton's Principle - Hamilton's Equation - Other variational principle. **Chapter 4 : Sections 4.1 to 4.3 (Omit section 4.4)**
	UNIT – IV : Hamilton-Jacobi Theory : Hamilton Principle function – Hamilton-Jacobi Equation - Separability **Chapter 5 : Sections 5.1 to 5.3**
	UNIT-V : Canonical Transformation : Differential forms and generating functions – Special Transformations– Lagrange and Poisson brackets. **Chapter 6 : Sections 6.1, 6.2 and 6.3 (omit sections 6.4, 6.5 and 6.6)**
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	D. Greenwood, *Classical Dynamics*, Prentice Hall of India, New Delhi, 1985.
Reference Books	1. H. Goldstein, *Classical Mechanics,* (2nd Edition) Narosa Publishing House, New Delhi. 2. N.C.Rane and P.S.C.Joag, *Classical Mechanics*, Tata McGraw Hill, 1991. 3. J.L.Synge and B.A.Griffth, *Principles of Mechanics* (3rd Edition) McGraw Hill Book Co., New York, 1970.
Website and e-Learning Source	http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics, http://www.opensource.org, www.physicsforum.com

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO1: Demonstrate the knowledge of core principles in mechanics.

CLO2: Interpret and consider complex problems of classical dynamics in a systematic way.

CLO3: Apply the variation principle for real physical situations.

CLO4: Explore different applications of these concepts in the mechanical and electromagnetic fields.

CLO5: Describe and apply the concept of Angular momentum, Kinetic energy and Moment of inertia of a particle

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CLO 1	3	3	3	3	3	2	3	3	2	3
CLO 2	2	3	3	3	2	2	2	1	2	2
CLO 3	2	3	3	3	2	1	2	2	2	3
CLO 4	3	3	3	3	3	3	3	3	3	3
CLO 5	2	3	3	1	1	2	3	3	2	3

CLO-PO-PSO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO 1	3	3	3	3	3	2	2	2	3	2
CLO 2	3	3	3	3	3	2	2	2	3	2
CLO 3	3	3	2	2	3	2	2	2	3	2
CLO 4	3	3	2	2	3	2	2	2	3	2
CLO 5	3	3	3	3	3	2	2	2	3	2

Level of correlation: 3-High, **2**-Medium, **1**-Low

Title of the Course		**FUNCTIONAL ANALYSIS**					
Paper Number		**CORE XI**					
Category	Core	**Year**	II	**Credits**	5	**Course Code**	
		Semester	IV				
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
		5	1	--	6		
Pre-requisite		Elements of Real Analysis					
Objectives of the Course		To provide students with a strong foundation in functional analysis, focusing on spaces, operators and fundamental theorems. To develop student's skills and confidence in mathematical analysis and proof techniques.					

Course Outline	**UNIT-I :**Banach Spaces: The definition and some examples – Continuous linear transformations – The Hahn-Banach theorem – The natural imbedding of N in N^{**}- The open mapping theorem – The conjugate of an Operator. **Chapter 9:Sections 46-51**
	UNIT-II : Hilbert Spaces: The definition and some simple properties– Orthogonal complements–Ortho normal sets–The conjugate space H^*-The adjoint of an operator–self-adjoint operators-Normal and unitary operators – Projections. **Chapter10:Sections52-59**
	UNIT-III : Finite-Dimensional Spectral Theory: Matrices – Determinants and the spectrum of an operator –The spectral theorem. **Chapter 11:Sections 60-62**
	UNIT-IV : General Preliminaries on Banach Algebras**:** The definition and some examples – Regular and singular elements – Topological divisors of zero – The spectrum – The formula for the spectral radius– The radical and semi-simplicity. **Chapter 12:Sections 64-69**
	UNIT-V: The Structure of Commutative Banach Algebras: The Gelfand mapping – Application of the formular$(x) = \lim \|x^n\|^{1/n}$– Involutions in Banach algebras-The Gelfand-Neumark theorem. **Chapter 13:Sections 70-73**
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	G.F.Simmons, Introduction to Topology and Modern Analysis, McGraw Hill Education (India)Private Limited, New Delhi, 1963.

Reference Books	1. W.Rudin, Functional Analysis, McGraw Hill Education (India) Private Limited, New Delhi, 1973. 2. B.V. Limaye, Functional Analysis, New Age International,1996. 3. C. Goffman and G. Pedrick, First course in Functional Analysis, Prentice Hall of India, NewDelhi,1987. 4. E. Kreyszig, Introductory Functional Analysis with Applications, John Wiley & Sons, New York, 1978. 5. M. Thamban Nair, Functional Analysis, A First course, Prentice Hall of India, New Delhi, 2002.
Website and e-Learning Source	http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics, http://www.opensource.org, http://en.wikiepedia.org

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO1: Understand the Banach spaces and Transformations on Banach Spaces.
CLO2: Prove Hahn Banach theorem and open mapping theorem.
CLO3: Describe operators and fundamental theorems.
CLO4: Validate orthogonal and orthonormal sets.
CLO5: Analyze and establish the regular and singular elements.

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**
CLO 1	3	3	3	3	3	2	3	3	2	3
CLO 2	2	3	3	3	2	2	2	1	2	2
CLO 3	2	3	3	3	2	2	2	2	2	3
CLO 4	3	3	3	3	3	2	2	3	3	3
CLO 5	2	3	3	1	1	2	2	3	2	3

CLO-PO-PSO Mapping

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CLO 1	3	3	3	3	3	2	2	2	-	2
CLO 2	3	3	3	3	3	2	2	2	-	2
CLO 3	3	3	2	2	3	2	2	2	-	2
CLO 4	3	3	2	2	3	2	2	2	-	2
CLO 5	3	3	3	3	3	2	2	2	1	2

Level of correlation: 3-High, **2**-Medium, **1**-Low

Title of the Course		**DIFFERENTIAL GEOMETRY**					
Paper Number		**CORE XII**					
Category	Core	**Year**	II	**Credits**	5	**Course Code**	
		Semester	IV				
Instructional Hours		**Lecture**	**Tutorial**		**Lab Practice**	**Total**	

per week	5	1	--	6
Pre-requisite	Linear Algebra concepts and Calculus			
Objectives of the Course	This course introduces space curves and their intrinsic properties of a surface and geodesics. Further the non-intrinsic properties of surface and the differential geometry of surfaces are explored			
Course Outline	**UNIT-I : Space curves:** Definition of a space curve – Arc length – tangent – normal and binormal – curvature and torsion – contact between curves and surfaces- tangent surface- involutes and evolutes- Intrinsic equations – Fundamental Existence Theorem for space curves- Helies. **Chapter I : Sections 1 to 9.**			
	UNIT-II :Intrinsic properties of a surface: Definition of a surface – curves on a surface – Surface of revolution – Helicoids – Metric- Direction coefficients – families of curves- Isometric correspondence- Intrinsic properties. **Chapter II: Sections 1 to 9.**			
	UNIT-III : Geodesics: Geodesics – Canonical geodesic equations – Normal property of geodesics- Existence Theorems – Geodesic parallels – Geodesics curvature- Gauss- Bonnet Theorem – Gaussian curvature- surface of constant curvature. **Chapter II: Sections 10 to 18.**			
	UNIT-IV : Non Intrinsic properties of a surface: The second fundamental form- Principle curvature – Lines of curvature – Developable - Developable associated with space curves and with curves on surface - Minimal surfaces – Ruled surfaces. **Chapter III: Sections 1 to 8.**			
	UNIT-V :Differential Geometry of Surfaces : Compact surfaces whose points are umblics- Hilbert's lemma – Compact surface of constant curvature – Complete surface and their characterization – Hilbert's Theorem – Conjugate points on geodesics. **Chapter IV : Sections 1 to 8 (Omit 9 to 15).**			
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)			

Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	T.J.Willmore, *An Introduction to Differential Geometry,* Oxford University Press,(17th Impression) New Delhi 2002. (Indian Print)
Reference Books	1. Struik, D.T. *Lectures on Classical Differential Geometry*, Addison – Wesley, Mass. 1950. 2. Kobayashi. S. and Nomizu. K. *Foundations of Differential Geometry,* Inter science Publishers, 1963. 3. Wilhelm Klingenberg: *A course in Differential Geometry*, Graduate Texts in Mathematics, Springer-Verlag 1978. 4. J.A. Thorpe *Elementary topics in Differential Geometry*, Under- graduate Texts in Mathematics, Springer - Verlag 1979.
Website and e-Learning Source	http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics, http://www.opensource.org, www.physicsforum.com

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO1: Explain space curves, Curves between surfaces, metrics on a surface, fundamental form of a surface and Geodesics.

CLO2: Evaluate these concepts with related examples.

CLO3: Compose problems on geodesics.

CLO4: Recognize applicability of developable.

CLO5: Construct and analyze the problems on curvature and minimal surfaces

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CLO 1	3	3	3	3	3	2	3	3	2	3
CLO 2	2	3	3	3	2	2	2	1	2	2
CLO 3	2	3	3	3	2	2	2	2	2	3
CLO 4	3	3	3	3	3	2	2	3	3	3
CLO 5	2	3	3	1	1	2	2	3	2	3

CLO-PO-PSO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO 1	3	3	3	3	3	2	2	2	-	2
CLO 2	3	3	3	3	3	2	2	2	-	2
CLO 3	3	3	2	2	3	2	2	2	-	2
CLO 4	3	3	2	2	3	2	2	2	-	2
CLO 5	3	3	3	3	3	2	2	2	1	2

Level of correlation: 3-High, **2**-Medium, **1**-Low

SEMESTER-III-3.7-Internship / Industrial Activity

Subject Code	Subject Name	Category	L	T	P	O	Credits	Inst. Hours	Marks		
									CIA	External	Total
	Internship / Industrial Activity	IA	-	-	Y	-	2	-	25	75	100

Learning Objectives	
CO1	To enhance student to work as team work.
CO2	To equipped the student with the skill and desire to solve societal problems
CO3	To developed work ethic.
CO4	To improve communication skill and responsibilities among students
CO5	To explore, experience and apply the academic knowledge in ground

Course Outcomes		
Course Outcomes	On completion of this course, students will / can;	
CO1	Enhance the professional competency to conduct field work.	PO1
CO2	Gain practical knowledge related to their studies.	PO4, PO6
CO3	Help student to understand the subject theories and methodology better.	PO1, PO2
CO4	Gain particle skill and knowledge.	PO4, PO5, PO6
CO5	Increase the employment prospect of the student	PO3, PO8

Methods of Evaluation		
Internal Evaluation	Certificate from the Organisation	25 Marks
	Viva Voce Examination	
External Evaluation	Internship report	75 Marks
	Total	100 Marks

Methods of Assessment	
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, short summary or overview
Application (K3)	Suggest idea/concept with examples, suggest formulae, solve problems, Observe, Explain
Analyze (K4)	Problem-solving questions, finish a procedure in many steps, Differentiate between various ideas, Map knowledge
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**
CO 1	3	3	3	3	2	3	2	3	3	3
CO 2	3	3	3	3	3	3	3	3	3	3
CO 3	3	3	3	3	3	3	3	3	3	3
CO 4	3	3	3	3	3	3	3	2	3	3
CO 5	3	3	3	3	3	3	3	3	3	3

CO-PO-PSO Mapping

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO 1	2	3	3	3	2	3	2	3	2	3
CO 2	3	3	3	3	3	3	2	3	3	3
CO 3	3	2	3	3	3	3	2	3	3	3
CO 4	3	3	3	3	3	3	3	3	3	3
CO 5	3	3	3	3	3	3	3	3	3	3

Level of correlation: 3-High, **2**-Medium, **1**-Low

SEMESTER-IV 4.3-Project with Viva Voce

Subject Code	**Subject Name**	**Category**	**L**	**T**	**P**	**O**	**Credits**	**Inst. Hours**
	Project with Viva Voce	PVV	Y	-	Y	Y	7	10
Learning Objectives								
CO1	To assess the student dissertation for the award of degree, jointly by supervisor and one external examiner affiliated to the University of Madras.							

CO2	To develop confident and empowers student for future career.	
CO3	To better prepare students for solving real-world problems and issues while teaching them, encouraging giving additional information related to their topic.	
CO4	To developed student interpersonal skills.	
CO5	To encourages students to develop a balanced, diverse approach to solving real-societal problems, both on their own and in a team	
Course Outcomes		
Course Outcomes	On completion of this course, students will / can;	
CO1	Gives the student a skill such as problem solving, and helps to develop additional skills integral to their future, such as critical thinking and time management.	PO1
CO2	Enhance their knowledge through particles experience.	PO1, PO2
CO3	Be developed interpersonal skills and decision-making skills.	PO4, PO6
CO4	Give a platform to demonstrate his/her abilities.	PO4, PO5, PO6
CO5	Be able to identify the strength and weakness, which will help them to enhance and improve their ability.	PO3, PO8
Methods of Evaluation		
Internal Evaluation	Dissertation Submission	50 Marks
External Evaluation	Viva Voce Examination	50 Marks
	Total	100 Marks
Methods of Assessment		
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions	
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, short summary or overview	
Application (K3)	Suggest idea/concept with examples, suggest formulae, solve problems, Observe, Explain	
Analyze (K4)	Problem-solving questions, finish a procedure in many steps, Differentiate between various ideas, Map knowledge	
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons	
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations	

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**
CO 1	3	3	3	3	2	3	2	3	3	3
CO 2	2	3	3	3	3	3	3	3	3	3
CO 3	3	2	3	1	2	3	3	3	3	3
CO 4	3	3	3	3	2	3	3	2	3	3

CO 5	3	3	3	3	2	3	2	3	3	3

CO-PO-PSO Mapping

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO 1	2	3	3	3	2	2	3	3	2	3
CO 2	3	3	3	3	3	3	3	3	3	3
CO 3	3	2	3	3	3	2	3	3	3	3
CO 4	3	3	3	3	3	2	2	3	3	3
CO 5	3	3	3	3	2	2	3	3	3	3

Level of correlation: 3-High, **2**-Medium, **1**-Low

4.5 Skill Enhancement Course / Professional Competency Skill

Training for Competitive Examinations

- Mathematics for NET / UGC - CSIR/ SET / TRB Competitive Examinations (2 hours)
- General Studies for UPSC / TNPSC / Other Competitive Examinations (2 hours)

(OR)

Mathematics for Advanced Research Studies (4 hours)

4.6-Extension Activity

Subject Code	**Subject Name**	**Category**	**L**	**T**	**P**	**O**	**Credits**	**Inst. Hours**	**Marks**		
									CIA	**External**	**Total**
	Extension Activity	EA	Y	-	-	-	1	-	25	75	100
Learning Objectives											
LO1	Extension activities concentrates on putting across in an understandable manner new ideas and improved technologies of practical utility to the rural, tribal and urban privileged and underprivileged people.										
LO2	Enables students to use the newly acquired knowledge and skills to improve their general standard of living.										
LO3	It is a social science that attempts to adopt various strategies of change in the behaviour patterns of people through technological and scientific innovations for the improvement of their standard of living.										
LO4	The idea behind the extension work is the coming together for the task of social upliftment.										

LO5	Students typically develop leadership and teamwork skills and become more attuned to working amongst populations of varying ethnicity or socioeconomic status.	
Course Outcomes		
Course Outcomes	On completion of this course, students will / can;	
CO1	Is a learning-teaching methods connect meaningful community service to academic curricula	PO1, PO8
CO2	Service-learning blends community service goals and formal and informal (standard/academic and experiential/non-standard) educational goals in a manner that benefits participants and recipients.	PO1, PO2
CO3	Extension activities and learning is a set of techniques and tools that can strengthen community relationships and connections.	PO5, PO3
CO4	Extension contributes to national development programmers.	PO4, PO6
CO5	It enhances leadership and team work qualities among the students	PO6, PO4
Methods of Evaluation		
Internal Evaluation	Continuous Performance Assessment and Viva Voce	25 Marks
External Evaluation	Extension – Fieldwork Report	75 Marks
	Total	100 Marks
Methods of Assessment		
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions	
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, short summary or overview	
Application (K3)	Suggest idea/concept with examples, suggest formulae, solve problems, Observe, Explain	
Analyze (K4)	Problem-solving questions, finish a procedure in many steps, Differentiate between various ideas, Map knowledge	
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons	
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations	

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**
CO 1	3	3	3	3	2	3	2	3	3	3

CO 2	3	3	3	3	3	3	3	3	3	3
CO 3	3	3	3	1	2	3	3	3	3	3
CO 4	3	3	3	3	2	3	3	3	3	3
CO 5	3	3	3	3	2	3	3	3	3	3

CO-PO-PSO Mapping

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO 1	3	3	3	3	2	2	2	3	2	3
CO 2	3	3	3	3	3	3	3	3	3	3
CO 3	3	2	3	3	2	2	3	3	3	3
CO 4	3	3	3	3	3	2	3	3	3	3
CO 5	3	3	3	3	3	2	2	3	2	3

Level of correlation: 3-High, **2**-Medium, **1**-Low

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ELECTIVE COURSES

Courses are grouped (Group A to Group F) so as to include topics from Pure Mathematics (PM), Applied Mathematics (AM), Industrial Components (IC) and IT Oriented (ITC) courses for flexibility of choice by the stakeholders / institutions.

Semester I : Elective I

Elective I to be chosen from Group A

Group A: (PM/AP/IC/ITC)

1. **Number Theory and Cryptography**
2. **Graph Theory and Applications**
3. **Lie Groups and Lie Algebras**
4. **Rings and Modulus**

Title of the Course		**NUMBER THEORY AND CRYPTOGRAPHY**					
Paper Number							
Category	Group A Elective	**Year**	I	**Credits**	3	**Course Code**	
		Semester	I				
Instructional Hours per week		**Lecture**	**Tutorial**		**Lab Practice**	**Total**	
		4	1		--	5	
Pre-requisite		UG level Number Theory					

Objectives of the Course	• To understand fundamental number-theoretic algorithms such as the Euclidean algorithm, the Chinese Remainder algorithm, binary powering, and algorithms for integer arithmetic. • To understand fundamental algorithms for symmetric key and public-key cryptography. • To understand the number-theoretic foundations of modern cryptography and the principles behind their security. • To implement and analyze cryptographic and number-theoretic algorithms.
Course Outline	**UNIT I:** Elementary Number Theory: Time Estimates for doing arithmetic – divisibility and Euclidean algorithm – Congruences – Application to factoring. Chapter 1
	UNITII : Introduction to Classical Crypto systems – Some simple crypto systems – Enciphering matrices DES Chapter 3
	UNITIII : Finite Fields, Quadratic Residues and Reciprocity (Chapter 2)
	UNITIV: Public Key Cryptography Chapter 4
	UNITV: Primality, Factoring, Elliptic curves and Elliptic curve crypto systems (Chapter 5, sections 1,2,3 &5 (omit section 4), Chapter 6, sections 1& 2 only)
Extended Professional Component	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	1. Neal Koblitz, A Course in Number Theory and Cryptography, Springer-Verlag, New York,1987
Reference Books	1. I.Niven and H.S.Zuckermann, An Introduction to Theory of Numbers (Edn. 3), Wiley Eastern Ltd., New Delhi,1976 2. David M.Burton, Elementary Number Theory, Brown Publishers, Iowa,1989 3. K.Ireland and M.Rosen, A Classical Introduction to Modern Number Theory, Springer Verlag, 1972 4. N.Koblitz, Algebraic Aspects of Cryptography, Springer 1998.
Website and e-Learning Source	1. https://nptel.ac.in/courses/111101137 2. https://archive.nptel.ac.in/courses/106/103/106103015/ 3. https://onlinecourses-archive.nptel.ac.in/noc17_cs36/preview

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO 1: Illustrate the implications of properties of divisibility and primes

CLO 2: Distinguish the DES and the AES.

CLO 3: Understanding the Law of Quadratic Reciprocity & Quadratic Residues.

CLO 4: Define the fundamentals of cryptography, such as encryption, Authentication and digital signature.

CLO 5: Explain how elliptic curves are used in certain Crypto-graphic algorithms.

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CLO 1	3	3	3	3	2	3	2	3	3	3
CLO 2	3	3	3	3	3	3	3	3	3	3
CLO 3	3	3	1	2	2	3	3	3	3	3
CLO 4	3	3	3	3	2	3	3	3	3	3
CLO 5	3	3	3	3	2	3	3	3	3	3

CO-PO-PSO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO 1	3	3	3	3	2	2	3	3	2	3
CLO 2	3	3	3	3	3	3	3	3	2	3
CLO 3	3	3	1	2	2	2	3	3	2	3
CLO 4	3	3	3	3	2	2	3	3	2	3
CLO 5	3	3	3	3	2	2	3	3	2	3

Level of correlation: 3-High, **2**-Medium, **1**-Low

Title of the Course		**GRAPH THEORY WITH APPLICATIONS**					
Paper Number		**Elective**					
Category	**Group A Elective**	**Year**	I	**Credits**	3	**Course Code**	
		Semester	I				
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
		4	1	--	5		
Pre-requisite		UG level Graph Theory knowledge					
Objectives of the Course		Develop advanced knowledge in Artificial intelligence, Intelligent Agents, Advanced Machine Learning, Artificial Intelligence algorithms and applications of Artificial Intelligence.					
Course Outline		**UNIT-I:** Graphs and graph models- connected graphs – common classes of graphs – the degree of a vertex – regular graphs – degree sequence. (Chapter 1: Sections 1.1-1.3; Chapter 2: Sections 2.1-2.3)					

	UNIT-II: The definition of isomorphism – isomorphism as a relation - bridges – trees - Cut vertices – Blocks. (Chapter 3: Sections 3.1-3.2; Chapter 4: Sections 4.1-4.2; Chapter 5: Sections 5.1-5.2)
	UNIT-III: Connectivity-Eulerian graphs - Hamiltonian graphs – Strong digraphs – Tournaments. (Chapter 5: Section 5.3; Chapter 6: Sections 6.1-6.2; Chapter 7: Sections 7.1-7.2)
	UNIT-IV: Matchings – factorization - planar graphs (Chapter 8: Sections 8.1-8.2; Chapter 9: Sections 9.1)
	UNIT-V: The four color problem - vertex coloring - edge coloring -The center of a graph-Distant vertices-The domination number of a graph. (Chapter 10: Sections 10.1 - 10.3; Chapter 12: Section 12.1-12.2; Chapter 13: Section 13.1)
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Ability to apply theoretical and advanced knowledge to solve the real world problems.
Recommended Text	Gary Chartrand and Ping Zhang, Introduction to Graph Theory, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2006.
Reference Books	1. J.A. Bondy and U. S. R. Murty, Graph theory with applications, The MacMillan Press Ltd., 1976. 2. Choudum, A First Course in Graph Theory, Laxmi Publications, 2000.
Website and e-Learning Source	

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO 1. identify the types of graphs
CLO 2. determine the chromatic number and domination number
CLO 3. generate graph models for real time problems
CLO 4. solve real time problems using various methods in graph theory

CLO 5. illustrate various characteristics of graphs
CLO 6. categorize the graphs using isomorphism

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CLO 1	3	3	3	3	2	3	2	3	3	3
CLO 2	3	3	3	3	3	3	3	3	3	3
CLO 3	3	3	3	1	2	3	3	3	3	2
CLO 4	3	3	3	3	2	3	3	3	3	2
CLO 5	3	3	3	3	2	3	3	3	3	2

CO-PO-PSO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO 1	3	3	3	3	2	2	2	3	1	3
CLO 2	3	3	3	3	3	3	3	3	2	3
CLO 3	3	2	3	3	2	2	3	3	2	3
CLO 4	3	3	3	3	3	2	3	3	2	3
CLO 5	3	3	3	3	3	2	2	3	1	3

Level of correlation: 3-High, **2**-Medium, **1**-Low

Title of the Course		**LIE GROUPS and LIE ALGEBRAS**					
Paper Number							
Category	Group A Elective	**Year**	I	**Credits**	3	**Course Code**	
		Semester	I				
Instructional Hours per week		**Lecture**	**Tutorial**		**Lab Practice**	**Total**	
		4	1		--	5	
Pre-requisite		UG level linear algebra and matrix groups.					
Objectives of the Course		1. In physics, Lie groups appear as symmetry groups of physical systems, and their Lie algebras (tangent vectors near the identity) may be thought of as infinitesimal symmetry motions. 2. Lie algebras and their representations are used extensively in physics, notably in quantum mechanics and particle physics.					
Course Outline		**UNITI:**Matrix Lie Groups Chapter 1					
		UNITII: The Matrix Exponential Chapter 2					
		UNITIII: Lie Algebras Chapter 3					
		UNITIV: Basic Representation Theory Chapter 4					
		UNITV: Semisimple Lie Algebras Chapter 7					
Extended Professional Component		Questions related to the above topics, from various competitive examinations UPSC / TNPSC / others to be solved (To be discussed during the Tutorial hour)					

Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	1. Brain Hall, Lie Groups, Lie Algebras and Representations: An Elementary Introduction (Second Edition), Springer, USA, 2015.
Reference Books	1. V. S. Varadarajan, Lie groups, Lie algebras and their representations, Sringer 1984. 2. Brian Hall, Lie groups, Lie algebras and representations, Springer 2003. 3. Barry Simon, Representations of finite and compact groups, AMS 1996. 4. A. W. Knapp, Representation theory of semismiple Lie groups. An overview based on examples, Princeton university press 2002. 5. S. Kumaresan S, A course in differential geometry and Lie groups, Texts and Readings in Mathematics, 22. Hindustan Book Agency, New Delhi, 2002.
Website and e-Learning Source	1. https://archive.nptel.ac.in/courses/111/108/111108134/ 2. https://www.digimat.in/nptel/courses/video/111108134/L42.html

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO 1: demonstrate systematic understanding of key aspects of Matrix Lie Groups and Lie Lie groups

CLO 2: determine the exponential of a matrix.

CLO 3: differentiate Lie groups and Lie Algebras

CLO 4: find the representation of sl(2 ; C).

CLO 5: explain reductive Lie algebra

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CLO 1	3	3	3	2	2	3	2	3	3	3
CLO 2	3	3	3	2	3	3	3	2	3	3
CLO 3	3	3	3	2	2	3	3	2	3	2
CLO 4	3	3	3	2	2	3	3	2	3	2
CLO 5	3	3	3	2	2	3	3	3	3	2

CO-PO-PSO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO 1	3	1	3	3	2	2	2	3	3	3
CLO 2	3	2	3	3	3	3	3	3	3	3
CLO 3	3	2	3	3	2	2	3	3	3	3
CLO 4	3	2	3	3	3	2	3	3	3	3
CLO 5	3	1	3	3	3	2	2	3	3	3

Level of correlation: 3-High, **2**-Medium, **1**-Low

Semester	Course Code	Title of the Course	Category	Hours/ Week	L	T	P	C
I		**RINGS AND MODULES**	**Group A Elective**	**5**	**4**	**1**	**-**	**3**

Course Objectives:

1. This course starts with basic concepts of rings and discuss about special rings viz., matrix rings, ring of quaternion's, group ring etc.
2. It shall discuss and analyze the properties and interlinks between the concepts of Euclidean ring, Principal Ideal Domain, Unique Factorization Domain and Integral Domain.
3. In this course a new algebraic structure, namely, Modules is introduced and studied in detail. Modules are the generalization of vector spaces when the underlying field is replaced by an arbitrary ring.

Course Outcomes (COs):

On completion of this course the students will be able to

Course Outcome No.	Course Outcome	Knowledge Level Upto
CO1	Determine the number of zero-divisor of a finite ring	**K3**
CO2	Infer the irreducible element and prime element.	**K4 & K6**
CO3	Define Dedekind-Hasse norm and give an example.	**K1 & K2**
CO4	Locate and use Eisenstein criterion to solve problems in polynomial ring.	**K4**
CO5	Analyze different algebraic structures and their properties	**K4**
K1=Remember, K2=Understand, K3=Apply, K4=Analyze, K5=Evaluate, K6= Create		

Course Outline:

Unit I: Introduction to Rings – Integral Domains (12 hours)

Unit II: Ideals and Factor Rings – Ring Homomorphisms (12 hours)

Unit III: Polynomial Rings – Factorization of Polynomials (12 hours)

Unit IV: Divisibility in Integral Domains (12 hours)

Unit V: Introduction to Module Theory: Basics definitions and examples - Quotient modulesand Module homomorphism - Generation of modules, Direct sums, and Free modules. (12 hours)

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	3	3	2	2	3	2	3	1	3
CO 2	3	3	3	2	3	3	3	3	2	3
CO 3	3	2	2	2	2	3	3	3	2	3
CO 4	3	2	2	2	2	3	3	3	2	-
CO 5	3	2	2	2	2	3	3	3	1	-

CO-PO-PSO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	3	1	3	3	2	2	2	3	3	3
CO 2	3	2	3	3	3	3	3	2	3	3
CO 3	3	2	3	3	2	2	3	2	3	2
CO 4	3	2	3	3	3	2	3	2	3	2
CO 5	3	1	3	3	3	2	2	3	3	2

S-Strong(3) M-Medium (2) L-Low (1)

Text Book:

1. Joseph A. Gallian, Contemporary Abstract Algebra (Seventh Edition),Brooks/Cole-Cengage Learning, USA, 2010

   Unit I to IV: Chapters 12 to 18
2. David S. Dummit and Richard M. Foote, Abstract Algebra (Third Edition),John Wiley & Sons, New Delhi, 2011
   Unit V: Chapter 10(Sections 10.1 to 10.3)

Reference Books:

1. I. N. Herstein, Abstract Algebra (Third Edition), Prentice-Hall, USA, 1990.
2. J. B. Fraleigh, A First Course in Abstract Algebra, 7th edition, Pearson EducationIndia, New Delhi, 2008.
3. P. B. Bhattacharya, S. K. Jain and S. R. Nagpaul, Basic Abstract Algebra, Second Edition, Cambridge University Press

Webliography:

1. https://nptel.ac.in/courses/111/106/111106131/
2. https://nptel.ac.in/courses/111/102/111102009/
3. https://nptel.ac.in/courses/111/106/111106098/

Elective II to be chosen from Group B

Group B:(PM/AP/IC/ITC)

1. **Programming in C++ and Numerical Methods**
2. **Mathematical Programming**
3. **Fuzzy Sets and Their Applications**
4. **Formal Languages and Automata Theory**
5. **Programming in C++ with practical (Second and Third Internal Assessment Tests are purely practical examinations. Teaching hours: 3T +2P)**

Semester	Course Code	Title of the Course	Category	Hours/ Week	L	T	P	Credits
I		PROGRAMMING IN C++ AND NUMERICAL METHODS	Group B Elective	5	4	1	-	3

Course Objective

1. To provide fundamental knowledge on C++ programming for formulating algorithms to solve numerical problems
2. To understand the difficulties of obtaining exact solution and knowing concept of error and the approximate solutions of the given Mathematical problems
3. To compute the numerical solutions to the given Mathematical equations both manually and via programming

Course Outcomes (Cos)

Course Outcome No.	Course Outcome	Knowledge Level Upto
CO1	Knowledge of creating own C++ Programming	K2, K6
CO2	Knowing the difference between exact and approximate solution. Finding approximate solutions to the given nonlinear equations	K2, K4,K6
CO3	Creating algorithm to solve matrix equations	K4, K6
CO4	Computing solutions to Interpolation problems	K4, K6
CO5	Solving Numerical differentiation and Integrations	K4, K6
K1=Remember,K2=Understand, K3=Apply,K4=Analyze,K5=Evaluate,K6= Create		

Course Outline	
Unit I	Introduction to C++ -- Tokens, Expressions – Control Structures – Functions in C++
Unit II	Numerical solutions of Nonlinear Equations
Unit III	Matrix Equations – Eigen Values and Eigen Vectors of Matrices
Unit IV	Intrerpolation Problems
Unit V	Numerical Integration – Numerical Differentiation

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	3	3	2	2	3	2	3	2	3
CO 2	3	3	3	2	3	3	3	3	2	3
CO 3	3	3	3	2	2	3	3	3	2	3
CO 4	3	3	3	2	2	3	3	3	2	1
CO 5	3	3	3	2	2	3	3	3	2	1

CO-PO-PSO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	3	1	3	3	2	2	2	3	3	3
CO 2	3	2	3	3	3	2	3	2	3	3
CO 3	3	2	3	3	2	2	3	2	3	2
CO 4	3	2	3	3	3	2	3	2	3	2
CO 5	3	1	3	3	3	2	2	3	-	-

Level of correlation: 3-High, **2**-Medium, **1**-Low

Text Books :
1. E. Balagurusamy, *Objected Oriented Programming with C++,* PHI Publishers (Third Edition)
2. Pallab Ghosh, *Numerical Methods with Computer Programs in C++*, PHI Publishers, 2009

Further Readings :
1. John R. Hubbard, *Schaum's Outline of Programming with C++,* McGraw Hill Publishers, 2000
2. Sastry S.S, Introductory Methods of Numerical Analysis, PHI Publishers, 2012
3. E. Balagurusamy, Numerical Methods, McGraw Hill Publishers, 2017

Semester	Course Code	Title of the Course	Category	Hours/ Week	L	T	P	C
I		**MATHEMATICAL PROGRAMMING**	**Group B Elective**	**5**	**4**	**1**	**-**	**3**

Course Objective

1. To provide fair knowledge of converting real life problems in to Linear Programming Problems.
2. To provide various techniques to solve Transportation and Assignment Problems
3. To gain knowledge on Integer and Dynamic programming problems and its solutions

Course Outcomes (Cos)

Course Outcome No.	Course Outcome	Knowledge Level Upto
CO1	Understanding the real-life problem and formulate it into Mathematical Problems.	**K2, K6**
CO2	Understanding various techniques and apply them to solve the LPP problems.	**K2,K3**
CO3	Solving Transportation and Assignment Problems	**K2,K3**
CO4	Analyzing LPP Problems and searching for integer solutions	**K2,K4**
CO5	Knowledge of solving Dynamic Problems	**K2,K3**
K1=Remember,K2=Understand, K3=Apply,K4=Analyze,K5=Evaluate,K6= Create		

Mathematical Programming	
Unit I	Linear Programming Problem – Method of Optimal Solution
Unit II	Primal and Dual Problem of LPP
Unit III	Transportation and Assignment Problem
Unit IV	Integer Programming Problem
Unit V	Dynamic Programming

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	3	3	1	3	3	2	3	2	3
CO 2	3	3	3	1	3	3	3	3	2	3
CO 3	3	3	3	1	3	3	3	3	2	3
CO 4	3	3	3	1	3	3	3	3	2	1
CO 5	3	3	3	1	3	3	3	3	2	1

CO-PO-PSO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	3	1	3	2	3	2	2	3	3	2
CO 2	3	2	3	2	2	2	3	2	3	2
CO 3	3	2	3	2	2	2	2	1	2	2
CO 4	3	2	3	2	2	2	1	2	1	2
CO 5	3	1	3	2	3	2	2	3	1	2

Level of correlation: 3-High, **2**-Medium, **1**-Low

Text Books :

1. Purna Chandra Biswal, Optimization in Engineering, Scitech Publication, 2009

Further Readings :

1. S.M. Sinha, Mathematical Programming : Theory and Methods, Elsevier Publication, 2005
2. Louis Brickman, Mathematical Introduction to Linear Programming and Game Theory, UGT, Springer-Verlag, 1989

Semester	Course Code	Title of the Course	Category	Hours/ Week	L	T	P	C
I		**FUZZY SET AND THEIR APPLICATIONS**	**Group B Elective**	**5**	**4**	**1**	**-**	**3**

Course Objectives:

1. To expose the students to Fuzzy theory as Fuzzy is one of the latest topic in Mathematics that has real life applications.
2. This topic introduces the concept of uncertainty and fuzziness in logic that willenable the student to develop their intuitive mind further.
3. The two years M.Sc. program is to prepare every student to face the competitive world outside. It will help them to acquire sufficient knowledge and skill in the subject that will make them competent in various areas of mathematics.

Course Outcomes (COs): On completion of this course the students will be able to

Course Outcome No.	Course Outcome	Knowledge Level Upto
CO1	Observe the need for Fuzzy set	**K1**
CO2	To generalize the various operations on sets to Fuzzy sets	**K2**
CO3	To establish relations on Fuzzy sets	**K3**
CO4	To hypothesize decision making in Fuzzy environment	**K6**
CO5	To appraise applications of Fuzzy sets	**K5**
K1=Remember, K2=Understand, K3=Apply, K4=Analyze,K5=Evaluate, K6= Create		

Course Outline:

Unit I: Crisp sets and fuzzy sets: Overview of Classical Sets, Membership Function, Heightof a fuzzy set – Normal and sub normal fuzzy sets – Support – Level sets, fuzzy points –cuts – Decomposition Theorems, Extension Principle.

Unit II: Operation on fuzzy sets: Standard fuzzy operations – Union, intersection and complement – properties De. Morgan's laws - alpha–Cuts of fuzzy operations.

Unit III: Fuzzy relations: Cartesian Product, Crisp relations – cardinality – operations and properties of Crisp and Fuzzy relations. Image and inverse image of fuzzy sets - Various definitions of fuzzy operations – Generalizations – Non interacting fuzzy sets, Tolerance andequivalence relations.

Unit IV: Decision making in Fuzzy environments: General Discussion – Individual Decision making – multi person decision making – multi criteria decision making – multi stage decision making – fuzzy ranking methods – fuzzy linear programming.

Unit V: Applications: Medicine – Economics – Fuzzy Systems and Genetic Algorithms –Fuzzy Regression – Interpersonal Communication – Other Applications.

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	3	2	3	2	3	3	1	2	3
CO 2	3	3	2	3	2	3	3	1	2	3
CO 3	3	3	2	3	2	3	3	1	2	3
CO 4	3	3	2	3	2	3	3	1	2	1
CO 5	3	3	2	3	2	3	3	1	2	1

CO-PO-PSO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	3	1	3	2	3	2	2	3	3	2
CO 2	3	2	3	2	2	2	3	2	3	2
CO 3	3	2	3	3	3	2	3	3	2	2
CO 4	3	2	3	3	3	2	3	3	1	2
CO 5	3	1	3	3	3	2	3	3	1	2

Level of correlation: 3-High, **2**-Medium, **1**-Low

Text Book:

George J.Klir and Bo Yuan, Fuzzy sets and Fuzzy Logic Theory and Applications, PHILeaning Private Limited, New Delhi (2009).

Reference Books:

1. A. K. Bhargava; Fuzzy Set Theory, Fuzzy Logic and their Applications, publishedby S. Chand Pvt. Limited (2013).
2. K.Pundir and R.Pundir, Fuzzy sets and their application, Published by A Pragatiedition (2012)
3. H.J.Zimmermann, Fuzzy set theory and its applications, Springer (2012).

Webliography: https://www.scientific.net>AMM.513-517.2186

Title of the Course		**FORMAL LANGUAGES AND AUTOMATA THEORY**					
Paper Number							
Category	Elective	**Year**		**Credits**	3	**Course Code**	
		Semester					
Instructional		**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
Hours per week		4	1	--	5		
Pre-requisite		UG level Number Theory					

Objectives of the Course	• Classify a given formal language into Regular, Context-Free, Context Sensitive, Recursive or Recursively Enumerable. **[Cognitive knowledge level: Understand]**. • Explain a formal representation of a given regular language as a finite state automaton, regular grammar, regular expression and Myhill-Nerode relation. [**Cognitive knowledge level: Understand**] • Design a Pushdown Automaton and a Context-Free Grammar for a givencontext-free language. [**Cognitive knowledge level** : **Apply**] • Design Turing machines as language acceptors or transducers. [**Cognitiveknowledge level: Apply]** • Explain the notion of decidability. [**Cognitive knowledge level:Understand]**
Course Outline	**UNIT I: (Introduction to Formal Language Theory and Regular Languages)** Introduction to formal language theory– Alphabets, Strings, Concatenation of strings, Languages. Regular Languages - Deterministic Finite State Automata (DFA) (Proof of correctness of construction not required), Nondeterministic Finite State Automata (NFA), Equivalence of DFA and NFA**,** Regular Grammar (RG), Equivalence of RGs and DFA.
	UNIT II : (More on Regular Languages) Regular Expression (RE), Equivalence of REs and DFA, Homomorphisms, Necessary conditions for regular languages, Closure Properties of Regular Languages, DFA state minimization (No proof required).
	UNIT III : (Myhill-Nerode Relations and Context Free Grammars) Myhill-Nerode Relations (MNR)- MNR for regular languages, Myhill-Nerode Theorem (MNT) (No proof required), Applications of MNT. Context Free Grammar (CFG)- CFG representation of Context Free Languages (proof ofcorrectness is required), derivation trees and ambiguity, Normal forms for CFGs.

	UNIT IV: (More on Context-Free Languages) Nondeterministic Pushdown Automata (PDA), Deterministic Pushdown Automata (DPDA), Equivalence of PDAs and CFGs (Proof not required), Pumping Lemma for Context-Free Languages (Proof not required), Closure Properties of Context Free Languages.
	UNIT V: (Context Sensitive Languages, Turing Machines) Context Sensitive Languages - Context Sensitive Grammar (CSG), Linear Bounded Automata. Turing Machines - Standard Turing Machine, Robustness of Turing Machine, Universal Turing Machine, Halting Problem, Recursive and Recursively Enumerable Languages. Chomsky classification of formal languages.
Extended Professional Component	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	1. Dexter C. Kozen, Automata and Computability, Springer (1999)
Reference Books	1. John E Hopcroft, Rajeev Motwani and Jeffrey D Ullman, Languages, and Computation, 3/e, Pearson Education, 2007 2. Michael Sipser, Introduction To Theory of Computation, Cengage Introduction to Automata Theory,
Website and e-Learning Source	

Course Outcomes: After the completion of the course the student will be able to

CO1	Classify a given formal language into Regular, Context-Free, Context Sensitive, Recursive or Recursively Enumerable. **[Cognitive knowledge level: Understand]**
CO2	Explain a formal representation of a given regular language as a finite state automaton, regular grammar, regular expression and Myhill-Nerode relation. [**Cognitive knowledge level: Understand**]

CO3	Design a Pushdown Automaton and a Context-Free Grammar for a givencontext-free language. [**Cognitive knowledge level** : **Apply**]
CO4	Design Turing machines as language acceptors or transducers. [**Cognitiveknowledge level: Apply]**
CO5	Explain the notion of decidability. [**Cognitive knowledge level: Understand]**

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	3	2	3	2	3	2	2	2	3
CO 2	3	3	2	3	2	3	2	2	2	3
CO 3	3	3	2	3	2	3	2	2	2	3
CO 4	3	3	2	3	2	3	2	2	2	1
CO 5	3	3	2	3	2	3	2	2	2	1

CO-PO-PSO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	3	2	3	2	3	2	2	3	3	2
CO 2	3	2	3	2	3	2	3	2	3	2
CO 3	3	2	2	3	2	2	3	3	2	2
CO 4	3	2	2	3	2	2	3	3	2	2
CO 5	3	2	2	3	2	2	3	3	2	2

Level of correlation: 3-High, **2**-Medium, **1**-Low

Semester	Course Code	Title of the Course	Category	Hours/ Week	L	T	P	C
I		**PROGRAMMING IN C++ WITH PRACTICAL**	**Group B Elective**	**5**	**3**	**-**	**2**	**3**

Course Objectives:

1. To introduce the basics of object oriented programming and to give detailed branching and looping structure in C++.
2. To master in creating and handling classes and class functions. To provide fair confident on working with pointers and files in C++.
3. To make students to write C++ programs with their own algorithm to solve the given any simple problems.

Course Outcomes (COs):

On completion of this course, the Students will be able to

Course Outcome No.	Course Outcome Details	Knowledge Level Upto
CO1	Propose basics and fundamental controls in C++ Programming	K6
CO2	Explain the importance of classes in C++	K5
CO3	Appraise the usage of operator overloading	K5
CO4	Analyze the inheritance and Polymorphism of classes in C++	K4
CO5	Acquire the basic knowledge on working with pointers and files	K3
K1=Remember, K2=Understand, K3=Apply, K4=Analyze, K5=Evaluate, K6= Create		

Course Outline:

Unit I Tokens, Expressions and Control structures-Functions in C++.
Unit II Classes and Objects.
Unit III Constructors and Destructors- Operator overloading and type conversions.
Unit IV Inheritance: Extending classes-Pointers, \virtual Functions and Polymorphism.
Unit V Working with files.

List of Practical's:

1. Programs to evaluate sin x, cos x, e^{-x} to 0.0001% accuracy.
2. Program to calculate the variance and standard deviation of a set of numbers.
3. Program to find product of matrices, inverse of a matrix using functions.
   Macro that obtains largest of three numbers.
4. Define a class of students and prepare a statement containing name, total marks of Ranks (using functions).
5. Program to check whether a number/ string is a palindrome without using the corresponding standard function.
6. Define a class string and exhibit the use of string manipulations.
7. Create a class FLOAT that contains one float data. Overload all the four arithmetic.
8. Write a C++ program implement a class 'Complex' of complex numbers. The class should be include member functions to add and subtract two complex numbers.
9. Write a C ++ program to implement a class for complex numbers with add and multiply as member functions. Overload ++ operator to increment a complex number.
10. Write a program in C++ to demonstrate friend function.

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	3	2	3	2	1	3	3	2	3
CO 2	3	3	2	3	2	1	3	3	2	3
CO 3	3	3	2	3	2	1	3	3	2	3
CO 4	3	3	2	3	2	1	3	3	2	1
CO 5	3	3	2	3	2	1	3	3	2	1

CO-PO-PSO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	3	3	3	3	3	2	2	3	3	2
CO 2	3	2	2	2	2	2	3	2	3	2
CO 3	3	2	2	2	2	2	3	3	2	2
CO 4	3	2	2	2	2	2	3	3	2	2
CO 5	3	3	3	3	3	2	3	3	2	2

Level of correlation: 3-High, **2**-Medium, **1**-Low

Text Book:

E. Balagurusamy, Objected Oriented Programming with C++, (Third Edition), (2007), Tata Mc Graw Hill, Unit I to V: Chapters 3 to 9 and 11.

Reference Books:

1. H. Schildt, C++: The Complete References(4th Ed.), McGraw Hill, 2017
2. Yashavant Kanetkar, Let us C++, BpB Publications, 2020

Webliography: https://nptel.ac.in/courses/106/105/106105151/

Semester II : Elective III

Elective III to be chosen from Group C

Group C:(PM/AP/IC/ITC)

1. **Algebraic Topology**
2. **Mathematical Statistics**
3. **Wavelets**
4. **Tensor Analysis and Relativity**
5. **Advanced Graph Theory**

Semester	Course Code	Title of the Course	Category	Hours/ Week	L	T	P	C
II		ALGEBRAIC TOPOLOGY	Group C Elective	4	3	1	-	3

Course Objectives:

1. To understand some fundamental ideas in algebraic topology;
2. To apply discrete, algebraic methods to solve topological problems.
3. To show how basic geometric structures may be studied by transforming them into algebraic questions.

Course Outcomes (COs): On completion of this course the students will be able to

Course Outcome No.	Course Outcome	Knowledge Level Upto
CO1	have knowledge of fundamental concepts and methods in algebraic topology, in particular singular homology.	K1 & K2
CO2	have knowledge of covering spaces and apply group actions on them.	K2, K3 & K4
CO3	understand homology and its types.	K4 & K5
CO4	have an idea of cohomology groups.	K3 & K6
CO5	apply his or her knowledge of algebraic topology to formulate and solve problems of a geometrical and topological nature in Mathematics	K4 & K5
K1=Remember, K2=Understand, K3=Apply, K4=Analyze, K5=Evaluate, K6= Create		

Course Outline:

Unit I: The fundamental group : Basic Constructions : Paths and homotopy- the fundamental group of the circle-induced homomorphisms –Van Kempen's theorem: Free products of groups- The Van Kampen theorem.

Unit II: Covering Spaces : Lifting Properties-the classification of covering spaces-Deck transformations and group actions- graphs and free groups

Unit III: Homology: Simplicial and singular homology - Δ- Complex- Simplicial homology- singular homology – homology invariance-exact sequences and excision-the equivalence of simplicial and singular homology.

Unit IV: Cohomology: Cohomology groups: The Universal Co-efficient theorem- Cohomology of spaces –Cup product: The cohomology ring – A Kenneth formula- Spaces with Polynomial Cohomology

Unit V: Homotopy theory : Homotopy groups: Definitions and basic constructions- Whitehead's theorem –Cellular Approximation- CW Approximation – excision for homotopy groups- the Hurewicz theorem.

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	3	2	2	2	2	3	3	2	3
CO 2	3	3	2	2	2	2	3	3	2	3
CO 3	3	3	2	2	2	2	3	3	2	3
CO 4	3	3	2	2	2	2	3	3	2	2
CO 5	3	3	2	2	2	2	3	3	2	2

CO-PO-PSO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	3	2	2	2	3	2	2	3	3	2
CO 2	3	3	3	3	2	2	3	2	3	2
CO 3	3	3	3	3	2	2	3	3	2	2
CO 4	3	3	3	3	2	2	3	3	2	2
CO 5	3	2	2	2	3	2	3	3	2	2

Level of correlation: 3-High, **2**-Medium, **1**-Low

Text Book:

Allen Hatcher, Algebraic Topology, Unit I to V: Chapter 1 (1.1 to1.3,1.A), Chapter 2 (2.1), Chapter 3(3.1, 3.2) and Chapter 4 (4.1,4.2 (related sections only)

Reference Books:

1. Andrew H.Wallace, An Introduction to Algebraic Topology, Dover Books on Mathematics.
2. J.P. May, A concise course in Algebraic Topology, Chicago lectures in Mathematics.
3. Rafael Ayala, Eladio Dominguez and Antonio Quintaro, Algebraic Topology, An Introduction, Alpha Science International Limited, 2012

Webliography:

1.*https://onlinecourses.nptel.ac.in ›*

2. https://appliedtopology.org › ...

3. https://www.maths.tcd.

Semester	Course Code	Title of the Course	Category	Hours/ Week	L	T	P	C
II		**MATHEMATICAL STATISTICS**	**Group C Elective**	**4**	**3**	**1**	**-**	**3**

Course Objectives:

1. This course lays the foundation to probability theory and statistical modelling ofoutcomes of real life random experiments through various statistical distributions.
2. It enables students maneuver mathematical probabilistic models for differentproblems, to analyze them and to interpret the results.
3. After completing this course, the student will be able qualified to join as statisticalofficer in department of survey and apply the concepts in data analysis.

Course Outcomes (COs): On completion of this course the students will be able to

Course Outcome No.	Course Outcome	Knowledge Level Upto
CO1	Illustrating the implications of the concepts of probability	**K3**
CO2	Comparing distributions of various kinds of discrete or continuous distributions	**K4**
CO3	Creating new distributions using the existing distributions	**K6**
CO4	Understanding t and F distributions and moment generating functions	**K2**
CO5	Determining solutions to the problems using central limittheorem	**K5**
K1=Remember, K2=Understand, K3=Apply, K4=Analyze, K5=Evaluate, K6= Create		

Course Outline:

Unit I : The probability set function - Random variables - Probability density function - Distribution function - Mathematical expectation - Special mathematical expectations - Chebyshev's Inequality **(12 hours)**

Unit II : Conditional probability - Marginal and conditional distributions - Stochastic independence Some special distributions: The Binomial, Trinomial and Multinomial distributions - The Poisson distribution. **(12 hours)**

Unit III : The Gamma and Chi-Square Distributions - The Normal distribution - The Bivariate normal distribution. Distributions of functions of random variables - Sampling theory - Transformations of variables of the discrete type - Transformations of variables of the continuous type. **(12 hours)**

Unit IV: The t and F distributions - Distributions of order statistics - The moment generating function technique. The distributions of $\bar{X}$ and nS^2/σ^2 - Expectations of functions of random variables. **(12 hours)**

Unit V : Limiting distributions, Stochastic convergence - Limiting moment generating functions - The Central limit theorem - Some theorems on limiting distributions. **(12 hours)**

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	3	2	2	2	2	3	3	1	3
CO 2	3	3	2	2	2	2	3	3	1	3
CO 3	3	3	2	2	2	2	3	3	1	3
CO 4	3	3	2	2	2	2	3	3	1	3
CO 5	3	3	2	2	2	2	3	3	1	3

CO-PO-PSO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	3	2	2	2	3	2	3	2	3	3
CO 2	3	3	3	3	2	2	2	3	1	3
CO 3	3	3	3	3	2	2	3	2	1	3
CO 4	3	3	3	3	2	2	2	3	1	3
CO 5	3	2	2	2	3	2	3	2	3	3

Level of correlation: **3**-High, **2**-Medium, **1**-Low

Text Book:

Robert V. Hogg and Allen T. Craig, Introduction to Mathematical Statistics (FourthEdition), Unit I to V: Chapters 1, 2 (except 1.1, 1.2, 1.3, 1.8 and 2.3), Chapters 3, 4 (except 4.5) and Chapter 5.

Reference Books:

1. K. L. Chung, A course in Probability, Academic Press, New York, 1974.
2. R. Durrett, Probability: Theory and Examples, (2nd Edition) Duxbury Press, New York,1996.
3. Y. S. Chow and H. Teicher, Probability Theory, 2nd Edition, Springer Verlag, Berlin,1988.

Webliography:

https://nptel.ac.in/courses/111/101/111101004/

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">WAVELETS</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8"></td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Group C Elective</td><td>Year</td><td>I</td><td>Credits</td><td>3</td><td>Course Code</td><td colspan="2"></td></tr>
<tr><td>Semester</td><td>II</td><td colspan="4"></td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>3</td><td colspan="2">1</td><td colspan="2">--</td><td colspan="2">4</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="8">UG level Differential Equations, Fourier transform and Linear Algebra</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="8">To establish the theory necessary to understand and use wavelets and related constructions.</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="8">UNIT-I:Signals and Systems
Basic concepts of signals and systems, Frequency spectrum of signals; Classification of signals: Discrete time signals and continuous time signals, periodic and non-periodic signals; Classification of systems: Linear, nonlinear, time-variant, time-invariant, stable and unstable systems.</td></tr>
<tr><td colspan="8">UNIT-II:: Haar Scaling Function and Wavelet
Time-Frequency Analysis Orthogonal functions, Orthonormal functions, Function spaces, Orthogonal basis functions, Haar scaling function, Haar spaces: Haar space, general Haar space V□; Haar wavelet, Haar wavelet spaces: Haar wavelet space general Haar wavelet space ; Decomposition and reconstruction, Time-frequency analysis, Orthogonal and orthonormal bases</td></tr>
<tr><td colspan="8">UNIT-III: Fourier Transforms and Wavelets
Discrete Fourier transform of a digital signal, Complex form of a Fourier series, Inverse discrete Fourier transform, Window Fourier transform, short time Fourier transform, Admissibility condition for a wavelet, Classes of wavelets: Haar, Morlet, Maxican hat, Meyer and Daubechies wavelets; Wavelets with compact support.</td></tr>
<tr><td colspan="8">UNIT-IV: Discrete Wavelet Transforms
Stationary and non-stationary signals, Haar transform, 1-level Haar transform, Multi-level Haar transform, Conservation and compaction of energy, Multiresolution analysis, Decomposition and reconstruction of signals using discrete wavelet transform (DWT).</td></tr>
<tr><td colspan="8">UNIT-V:Applications
Wavelet series expansion using Haar and other wavelets, Applications in signal compression, Analysis and classification of audio signals using DWT, Signal de-noising: Image and ECG signals</td></tr>
<tr><td colspan="2">Extended Professional Component</td><td colspan="8">Questions related to the above topics, from various competitive examinations UPSC / TNPSC / others to be solved
(To be discussed during the Tutorial hour)</td></tr>
<tr><td colspan="2">Skills acquired from this course</td><td colspan="8">Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill</td></tr>
<tr><td colspan="2">Recommended Text</td><td colspan="8">Charles K. Chui, An Introduction to Wavelets. Academic Press, 1992.</td></tr>
</table>

Reference Books	1. Ingrid Daubechies, Ten Lectures on Wavelets. SIAM, 1999. 2. Michael W. Frazier, An Introduction to Wavelets Through Linear Algebra. Springer-Verlag, 1999. 3. Stéphane Mallat, A Wavelet Tour of Signal Processing (3rd edition). Academic Press, 2008. 4. M.J. Roberts, Signals and Systems: Analysis Using Transform Methods and MATLAB. McGraw-Hill Education, 2004 5. David K. Ruch & Patrick J. Van Fleet, Wavelet Theory: An Elementary Approach with Applications. John Wiley & Sons, 2009 6. James S. Walker, A Primer on Wavelets and Their Scientific Applications (2nd edition). Chapman & Hall/CRC, Taylor & Francis, 2008.
Website and e-Learning Source	1. https://archive.nptel.ac.in/courses/108/101/108101093/ 2. https://onlinecourses.nptel.ac.in/noc23_ee32/preview

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO 1: Know basic concepts of signals and systems.

CLO 2: Understand the concept of Haar spaces.

CLO 3: Learn Fourier transform and wavelet transform of digital signals.

CLO 4: Learn applications of wavelets to the real-world problems.

CLO 5: Apply wavelets in signal processing and image processing.

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	3	2	2	2	2	3	3	2	3
CO 2	3	3	2	2	2	2	3	3	2	3
CO 3	3	3	2	2	2	2	3	3	2	3
CO 4	3	3	2	2	2	2	3	3	2	3
CO 5	3	3	2	2	2	2	3	3	2	3

CO-PO-PSO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	3	2	2	3	2	2	3	2	3	3
CO 2	3	3	3	3	2	2	3	3	1	3
CO 3	3	3	3	3	2	2	3	2	1	3
CO 4	3	3	3	3	2	2	3	3	1	3
CO 5	3	2	2	3	2	2	3	2	3	3

Level of correlation: 3-High, **2**-Medium, **1**-Low

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">TENSOR ANALYSIS AND RELATIVITY</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8"></td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Group C Elective</td><td>Year</td><td>I</td><td>Credits</td><td>3</td><td>Course Code</td><td colspan="2"></td></tr>
<tr><td>Semester</td><td>II</td><td colspan="4"></td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td colspan="2">Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td colspan="2">3</td><td colspan="2">1</td><td colspan="2">--</td><td>4</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="8">UG level Calculus and Mechanics knowledge</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="8">The course aims to introduce vector algebra and vector calculus and special relativity and relativistic kinematics, dynamics and accelerated systems.</td></tr>
<tr><td colspan="2">Course Outline</td><td colspan="8">UNIT-I TENSOR ALGEBRA
Systems of Different orders - Summation Convention - Kronecker Symbols - Transformation of coordinates in Sn - Invariants - Covariant and Contravariant vectors - Tensors of Second Order - Mixed Tensors - Zero Tensor - Tensor Field - Algebra of Tensors - Equality of Tensors - Symmetric and Skew –symmetric tensors - Outer multiplication, Contraction and Inner Multiplication - Quotient Law of Tensors - Reciprocal Tensor of Tensor - Relative Tensor - Cross Product of Vectors.
Chapter I : I.1 - I.3, I.7 and I.8 and Chapter II : II.1 - II.19</td></tr>
<tr><td colspan="2"></td><td colspan="8">UNIT II : TENSOR CALCULUS
Riemannian Space - Christoffel Symbols and their properties Chapter III: III.1 and III.2</td></tr>
<tr><td colspan="2"></td><td colspan="8">UNIT III : TENSOR CALCULUS (CONTD)
Covariant Differentiation of Tensors - Riemann - Christoffel Curvature Tensor - Intrinsic Differentiation.
Chapter III: III.3</td></tr>
<tr><td colspan="2"></td><td colspan="8">UNIT IV : SPECIAL THEORY OF RELATIVITY Galilean Transformation - Maxwell’s equations - The ether Theory - The Principle of Relativity- Relativistic Kinematics : Lorentz Transformation equations - Events and simultaneity - Example - Einstein Train - Time dilation - Longitudinal Contraction - Invariant Interval - Proper time and Proper distance - World line - Example - twin paradox - addition of velocities - Relativistic Doppler effect. Chapter 7 : Sections 7.1 and 7.2</td></tr>
<tr><td colspan="2"></td><td colspan="8">UNIT V : RELATIVISTIC DYNAMICS
Momentum - Energy - Momentum - energy four vector - Force - Conservation of Energy - Mass and energy - Example - inelastic collision - Principle of equivalence - Lagrangian and Hamiltonian formulations. Accelerated Systems : Rocket with constant acceleration - example - Rocket with constant thrust
Chapter 7 : Sections 7.3 and 7.4</td></tr>
<tr><td colspan="2">Extended Professional Component</td><td colspan="8">Questions related to the above topics, from various competitive examinations UPSC / TRB / TNPSC / others to be solved
(To be discussed during the Tutorial hour)</td></tr>
</table>

Skills acquired from this course	Apply problem-solving with relativity to diverse situations in physics, engineering and in other physical contexts.
Recommended Text	For Units I,II and III U.C. De, Absos Ali Shaikh and Joydeep Sengupta, Tensor Calculus, Narosa Publishing House, New Delhi, 2004. For Units IV and V D. Greenwood, Classical Dynamics, Prentice Hall of India, New Delhi, 1985.
Reference Books	1. J.L.Synge and A.Schild, Tensor Calculus, Toronto, 1949. 2. A.S.Eddington. The Mathematical Theory of Relativity, Cambridge University Press, 1930. 3. P.G.Bergman, An Introduction to Theory of Relativity, New York, 1942 4. C.E.Weatherburn, Riemannian Geometry and the Tensor Calculus, Cambridge, 1938
Website and e-Learning Source	**https://nptel.ac.in/courses**

Course Learning Outcome (for Mapping with POs and PSOs): Students will be able to

Course Outcome No.	Course Outcome	Knowledge Level Upto
CLO1	Explain the basic concepts of tensors	**K5**
CLO2	Understand role of tensors in Relativity Theory	**K2**
CLO3	Learn various transformations Galilean, Maxwell's and Lorentz with examples	**K4, K6**
CLO4	Know conservation of Energy - Mass and energy, Principle of equivalence - Lagrangian and Hamiltonian formulations.	**K1, K2**
CLO5	Apply Accelerated Systems : Rocket with constant acceleration - example - Rocket with constant thrust	**K3**
K1=Remember, K2=Understand, K3=Apply, K4=Analyze, K5=Evaluate, K6= Create		

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CLO 1	3	3	2	3	2	2	3	3	2	3
CLO 2	3	3	2	3	2	2	3	3	2	3
CLO 3	3	3	2	3	2	2	3	3	2	3
CLO 4	3	3	2	3	2	2	3	3	2	3
CLO 5	3	3	2	3	2	2	3	3	2	3

CO-PO-PSO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO 1	3	3	3	3	2	2	3	2	2	2
CLO 2	3	2	3	3	2	2	3	2	1	2
CLO 3	3	2	3	3	2	2	3	2	1	2

CLO 4	3	2	3	3	2	2	3	2	1	2
CLO 5	3	3	3	3	2	2	3	2	2	2

Level of correlation: 3-High, **2**-Medium, **1**-Low

Semester	Course Code	Title of the Course	Category	Hours/ Week	L	T	P	C
II		**ADVANCED GRAPH THEORY**	**Group C Elective**	**4**	**3**	**1**	**-**	**3**

Course Objectives:

1. This is a standard course in graph theory, whose aim is to present all usual basic concepts of graph theory, graph properties (with simplified proofs) and formulations of typical graph problems.
2. In recent years it has been studied for the reason that it has become essential for Graph Algorithms, Design and Analysis of Algorithms, Data Structure and many real world problems.
3. It develops the mathematical sophistication needed to understand what properties to search for in graphs (simple networks), and prove results about them using the knowledge about graphs' structure.

CourseOutcomes (COs):

On completion of this course the students will be able to

Course Outcome No.	Course Outcome	Knowledge Level Upto
CO1	Achieve command of the fundamental definitions and concepts of graph theory and exposed to emerging areas of research	**K1, K6**
CO2	Understand in depth proofs of some fundamental statements on graphs and able to solve new graph problems	**K2, K5**
CO3	Familiar with the major viewpoints and goals of graph theory: classification, extremality, optimization and sharpness, algorithms, and duality.	**K1**
CO4	Achieve proficiency in writing proofs, including those using basic graph theory proof techniques such as bijections, minimal counterexamples, and loaded induction and analyze them	**K2, K4**
CO5	Apply this knowledge in (especially) computer science applications and other branches of mathematics	**K3**
K1=Remember,K2=Understand, K3=Apply,K4=Analyze,K5=Evaluate,K6= Create		

Course Outline:

Unit I : Graphs - Graph isomorphism-Incidence and adjacency matrices – Subgraphs - Vertex degrees - Path and Connection cycles -Trees - Cut edges and bonds - Cut vertices - Cayley's formula. (12 hrs)

Unit II : Connectivity - Blocks - Euler tours – Hamilton cycles. **(12 hrs)**

Unit III : Matchings - Matching and coverings in bipartite graphs-Perfect matchings – Edge colorings: Edge chromatic number - Vizing's theorem. **(12 hrs)**

Unit IV: Independent sets-Ramsey's theorem-Vertex colorings: Chromatic number-Brook's theorem-Hajos' conjecture-Chromatic polynomials-Girth and chromatic number. **(12 hrs)**

Unit V : Plane and planar graphs -Dual graphs-Euler's formula- The Five Color theorem and The Four Color conjecture -Directed graphs. **(12 hrs)**

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	3	3	3	2	2	3	3	2	3
CO 2	3	2	2	3	2	2	3	3	2	3
CO 3	3	2	2	3	2	2	3	3	2	3
CO 4	3	2	2	3	2	2	3	3	2	3
CO 5	3	3	3	3	2	2	3	3	2	3

CO-PO-PSO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	3	3	3	3	2	2	3	2	2	2
CO 2	3	3	3	3	2	2	3	2	3	2
CO 3	3	3	3	3	2	2	3	2	3	2
CO 4	3	3	3	3	2	2	3	2	3	2
CO 5	3	3	3	3	2	2	3	2	2	2

Level of correlation: 3-High, **2**-Medium, **1**-Low

Text Book:

1. J.A. Bondy and U.S.R. Murty, Graph Theory with Applications by, The Macmillan Press Ltd,1976. Unit I to V: Sec. 1.1 - 1.7,2.1 - 2.4, Sec.3.1 &3.2, 4.1 & 4.2, Sec. 5.1- 5.3, 6.1 &6.2, Sec. 7.1, 7.2, 8.1 – 8.5, Sec. 9.1 – 9.3 & 9.6 and 10.1.

Reference Books:

1. D.B. West, *Introduction to Graph Theory*, New Delhi: Prentice-Hall of India, 2011.
2. G. Chatrand and L. Lesniak, Graphs and Digraphs, Fourth Edition, Boca Raton: CRC Press, 2004
3. R. Balakrishnan and K. Ranganathan, A Text Book of Graph Theory, New Delhi: Springer, 2008.

Webliography:

1. https://nptel.ac.in/courses/111/106/111106050/#
2. https://nptel.ac.in/courses/111/106/111106102/

Elective IV to be chosen from Group D

Group D :(PM/AP/IC/ITC)

1. Statistical Data Analysis using R Programming
2. Modelling and Simulation with Excel
3. Machine Learning and Artificial Intelligence
4. Neural Networks
5. Financial Mathematics
6. Mathematical Python
7. Resource Management Techniques

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">STATISTICAL DATA ANALYSIS USING R PROGRAMMING</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6"></td></tr>
<tr><td>Category</td><td>Group D Elective</td><td>Year</td><td>I</td><td>Credits</td><td>3</td><td>Course Code</td><td></td></tr>
<tr><td colspan="2"></td><td>Semester</td><td>II</td><td colspan="4"></td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td colspan="2">Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td colspan="2">3</td><td colspan="2">1</td><td colspan="2">--</td><td>4</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">UG level Statistics Knowledge</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">This course aims in imparting R programming skills to the learners for effective data analysis and visualization</td></tr>
<tr><td colspan="2" rowspan="4">Course Outline</td><td colspan="6">UNIT-I Introduction to R programming - Installing R and R Studio - R Studio over view working in the console - arithmetic operators -logical operators – functions.</td></tr>
<tr><td colspan="6">UNIT II :Data structures in R - creating variables - numeric, character and logical data – vectors – data frames – factors - sorting numeric, character, and factor vectors.</td></tr>
<tr><td colspan="6">UNIT III :Control statements in R – loop statements- R packages - installing and loading packages - setting up your working directory - working with missing data</td></tr>
<tr><td colspan="6">UNIT IV :Statistical graphs - Scatter Plots - Box Plots – Histograms – Bar plots – pie chart - ggplot2 package to visualize data – ggthemes for customization</td></tr>
</table>

	UNIT V : Descriptive statistics in R - measures of central tendency - measures of variability - skewness and kurtosis - summary functions –correlations – inferential statistics in R – parametric tests – non parametric tests
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Get an idea to collect, compile and visualize data using simple satistical functions
Recommended Text	Sandip Rakshit, R Programming for Beginners, McGraw Hill Education (India), 2017.
Reference Books	1. Seema Acharya, Data Analytics using R, McGraw Hill Education (India), 2018. 2. Peng, R.D.,R Programming for Data Science, Lean publishing, 2020. 3. Hadley Wickham and Garrett Gorlemund., R for Data Science, O'Reilly,2018.
Website and e-Learning Source	**https://www.learnvern.com/r-programming-tutorial/what-is-r**

Course Learning Outcome (for Mapping with POs and PSOs): Students will be able to

Course Outcome No.	Course Outcome	Knowledge Level Upto
CLO1	understand the fundamentals of R.	**K2**
CLO2	illustrate the loading, retrieval techniques of data.	**K3**
CLO3	understand how data is analyzed using simple functions	**K2, K4**
CLO4	Use flow control statements in simple programs	**K1, K2**
CLO5	Draw inferences employing statistical packages	**K5**
K1=Remember, K2=Understand, K3=Apply, K4=Analyze, K5=Evaluate, K6= Create		

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CLO 1	3	3	3	3	2	2	3	3	2	3
CLO 2	3	2	2	3	2	2	3	3	2	3
CLO 3	3	2	2	3	2	2	3	3	2	3
CLO 4	3	2	2	2	2	2	2	2	2	3
CLO 5	3	3	3	3	3	3	3	3	2	3

CO-PO-PSO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO 1	3	3	3	3	2	2	3	2	2	2
CLO 2	3	3	3	3	2	2	3	2	3	2
CLO 3	3	3	3	3	2	2	3	2	3	2
CLO 4	2	2	2	2	2	2	3	2	3	2
CLO 5	2	2	2	2	2	2	3	2	2	2

Level of correlation: 3-High, **2**-Medium, **1**-Low

Title of the Course		**MODELING AND SIMULATION WITH EXCEL**					
Paper Number							
Category	**Group D Elective**	**Year**	I	**Credits**	3	**Course Code**	
		Semester	II				
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
		4	1	--	5		
Pre-requisite		**None**					
Objectives of the Course		Gives an opportunity to develop the skills needed to build financial models. The course primarily focuses on models used for valuation, capital budgeting, cost of capital and portfolio models.					
Course Outline		**UNIT-I**Introduction Basics of MS-Windows – Desktop, Icon, creating, saving, and using of different documents and applications, MS- Office: Installing, Customizing, and Using different applications and tools in MS-Office package, Basics of MS-Word, Basics of MS Power Point.					
		UNIT II : Spreadsheets basics, Need for Spreadsheets, Work-Book, Work –Sheet, Parts of a MS-Excel Work-Sheet- Program area, Work area, Contents of Title-Bar, Manu-Bar, Contents of Manu Ribbons, Meaning of Cell- Cell address, Formula-Bar, Row Numbers, Column-Letters, Quick Access to Tool-Bar, Office Button, Floating Frames, Adding Work- Sheets in Sheet Tab, Status-Bar., and other features of Excel.					

	UNIT III : Selecting Cell and Range of Cells, Merging of Cells, Entering and Saving Data in the Cell, Named Cells, Need of Naming Cells, Entering, Storing, Copying Formula, Using different Arithmetic and logical Operators in Formula, Moving Cell with contents, Copying and Pasting of Cell and Cell Content, Freezing Cells, Editing of Cell Contents, using Cell Formatting Options – Editing Cell Size (increasing Column and Row size of a cell), Text Alignment, using Border, Comments option usage in Cell, Editing and Deleting Comments, Fill, Formatting Fonts, Text Warping, Text Rotate, Using Auto-fit to Adjust Rows and Columns Using of Short Cuts and Short-Cut Manu, Clear Contents in a Cell, Adding, Deleting and Copying Work-Sheet with in a Work-Book, Renaming a File or Work-Sheet, Inserting Multiple Work-Sheet at a time, Formatting a Work-Sheer Automatically, Sorting Textual & Numerical DATA, Sort Dates or Times, Sort by Cell Colour, Font Colour, or by icon, Sort by a custom list, Sort Rows, sort by more than column or row and other issues in sorting
	UNIT IV : Creating a Table, Changing the look of a table, Navigating in a Table, Selecting parts of a Table, Adding, Deleting New Rows/ Columns, Moving a Table, Working with the Total Row, Removing Duplicate rows from a table. Sorting and Filtering a table, Converting Table into Range. Formatting tools on the Home Tab, Mini Toolbar, Fonts, Text Alignment, Wrapping text to fit a cell, Colours and Shading, Borders and Lines, Miming Styles Conditional Formatting and Reporting: Format all Cells by using a Two Colour Scale, Format all Cells by using Data Bars quick formatting, Protecting, Protect a Work-Book, Un Protect Work-Book, Protect Work-Sheet Data, Unprotect Work-Sheet data, Spelling and Grammar Check, Referencing – Relative, Absolute, Mixed Referencing, Basic Functions Viz., SUM, AVERAGE, MAX, MIN, SQRT, TODAY, COUNT, COUNTIF, CHAR, AND, OR,NOT,VALUE.ROUND.
	UNIT V : Using Formulae to Find the roots of a Quadratic Equations, Formula of a Straight –line (Y=MX+C) to find the Slope of a straight line, Regression Formula, EMI Formula, Formulae used in calculating Banker Discount, Bankers gain, True Discount, Net-Present Value, Sum of AP and GP,) Using IF Condition, and using Multiple IF Condition in University Result Declaration.

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Able to demonstrate how to apply basic and advanced functions in Excel and use it to build models for financial, statistical and investment concepts. Students can implement portfolio optimization models to calculate efficient portfolios and the efficient frontier
Recommended Text	Microsoft Excel Latest Version Inside Out – Mark Doge and Craig Stinson – PHIL earning Private Limited, New Delhi – 110001.
Reference Books	1. Rajkumar S and Nagarajan G and Naveen Kumar M, Fundamentals of MS Excel, Jayvee International Publications, Bangalore. 2. Microsoft Excel Latest Version Inside Out – Mark Doge and Craig Stinson – PHIL earning PrivateLimited, New Delhi – 110001. 3. Excel 2013Bible ;John Walkenbach,Wiley 4. Financial Analysis and Modeling using Excel and VAB: Chandan Sengupta, Wiley 5. Excel DataAnalysis – Modeling and Simulation: Hector Guerreor, Springe 6. Microsoft Excel 2013: Data Analysis and Business Modeling:Winston, PHI 7. Excel Functions and Formulas: Bernd Held, BPB Publications.
Website and e-Learning Source	**https://nptel.ac.in/courses**

Course Learning Outcome (for Mapping with POs and PSOs) Students will be able to

Course Outcome No.	Course Outcome	Knowledge Level Upto
CLO1	Know fundamentals of Excel helps Students to learn how to start working with MS EXCEL right from basics to Tables	**K1**
CLO2	To understand the various templates and printing of their work.	**K2**
CLO3	To apply the most extensive tool used for many analysis in general and in Business Analytics in Particular, this module will	**K3**

	equip students with hands-on skills on excel operations	
CLO4	.Articulate and analyse the financial data	**K5, K4**
CLO5	To evaluate formulae used in calculating Banker Discount, Bankers gain, True Discount and Net-Present Value	**K5**
K1=Remember, K2=Understand, K3=Apply, K4=Analyze, K5=Evaluate, K6= Create		

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**
CLO 1	3	3	3	3	2	2	3	3	2	3
CLO 2	3	2	2	3	2	2	3	3	2	3
CLO 3	3	2	2	3	2	2	3	3	2	3
CLO 4	3	2	2	2	2	2	2	2	2	3
CLO 5	2	2	2	2	2	2	2	2	2	2

CO-PO-PSO Mapping

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CLO 1	3	3	3	3	2	2	3	2	2	2
CLO 2	3	3	3	3	2	2	3	2	3	2
CLO 3	3	3	3	3	2	2	3	2	3	2
CLO 4	3	3	3	3	3	3	3	3	3	3
CLO 5	2	2	2	2	2	2	3	2	2	2

Level of correlation: 3-High, **2**-Medium, **1**-Low

Title of the Course		**MACHINE LEARNING AND ARTIFICIAL INTELLIGENCE**					
Paper Number							
Category	Group D Elective	**Year**	I	**Credits**	3	**Course Code**	
		Semester	II				
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
		4	1	--	5		
Pre-requisite		UG level computer programming knowledge					
Objectives of the Course		Develop advanced knowledge in Artificial intelligence, Intelligent Agents, Advanced Machine Learning, Artificial Intelligence algorithms and applications of Artificial Intelligence.					
Course Outline		**UNIT-I:**Understanding Machine Learning -What Is Machine Learning? - Defining Big Data- Big Data in Context with Machine Learning - Leveraging the Power of Machine Learning- Descriptive analytics - Predictive analytics					

	UNIT-II: The Roles of Statistics and Data Mining with Machine Learning - Approaches to Machine Learning -Supervised learning -Unsupervised learning - Reinforcement learning - Neural networks
	UNIT-III: Topics of Artificial Intelligence, Timelines of Artificial Intelligence, Branches of Artificial Intelligence, Applications of Artificial Intelligence. - Intelligent agents - structure, types of agents, environment, autonomous agents. Problem Solving - Production Systems, State space representation.
	UNIT-IV: Knowledge Representation - Knowledge Management, Types of Knowledge, Knowledge representation-bases and structures - First Order logic, Unification algorithm, Frames, Conceptual Dependency, Scripts, Semantic network
	UNIT-V: Game playing - Minimax procedure, Alpha-Beta pruning, combined approach, Iterative Deepening
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Ability to apply theoretical and advanced knowledge to solve the real world problems.
Recommended Text	1. EthemAlpaydın "Introduction to Machine Learning Second Edition", The MIT Press Cambridge, Massachusetts, London, England 2.Stuart Russell and Peter Norvig – "Artificial Intelligence: A Modern Approach", 3 rd Edition Prentice Hall of India, New Delhi, 2009
Reference Books	1.Judith Hurwitz and Daniel Kirsch, Machine Learning For Dummies, IBM Limited Edition, Wiley, 2018. 2. Vinod Chandra S S, Anand H S- "Artificial Intelligence: Principles and Applications", Prentice Hall of India, New Delhi, 2020
Website and e-Learning Source	

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO1: Explain the basic concepts and applications of Machine learning.
CLO2: Compare and contrast different supervised machine learning algorithms. Explain the approaches of machine learning.
CLO3:Discuss Artificial Intelligence including topics, branches, and applications.
CLO4: Explain the significance of intelligent agents in the Artificial Intelligence.
CLO5: Illustrate how Artificial Intelligence works in Gaming applications (basics only).

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CLO 1	3	3	3	3	2	2	3	3	2	3
CLO 2	3	2	2	3	2	2	3	3	2	3
CLO 3	3	3	3	3	3	3	3	3	3	3
CLO 4	3	2	2	2	2	2	2	2	2	3
CLO 5	2	2	2	2	2	2	2	2	2	2

CO-PO-PSO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO 1	3	3	3	3	2	2	3	2	2	2
CLO 2	3	3	3	3	2	2	3	2	3	2
CLO 3	3	3	3	3	3	1	3	3	3	3
CLO 4	3	3	3	3	3	3	3	3	3	3
CLO 5	2	2	2	2	2	2	3	2	2	2

Level of correlation: 3-High, **2**-Medium, **1**-Low

Title of the Course		**NEURAL NETWORKS**							
Paper Number									
Category	**Group D Elective**	**Year**	I	**Credits**	3	**Course Code**			
		Semester	II						
Instructional Hours per week		**Lecture**		**Tutorial**		**Lab Practice**		**Total**	
		3		1		--		4	
Pre-requisite		UG level							
Objectives of the Course		1. enable students to understand important concepts and theories of artificial neural networks (ANNs) 2. enable students to understand how ANNs can be designed and trained 3. enable students to calculate simple examples of ANNs							
Course Outline		**UNIT I:**Introductory Concepts:'Neurons' and their basic function- Math review- Mathematical Machinery and Review- How and Why Perceptron's Can Compute Logic Statements- Training Perceptron's Using Supervised Learning Techniques- Training Multi-layer.							

	UNIT II: Neural Networks Using Supervised Learning Techniques: Recurrent Neural Networks and Unsupervised Learning: Optimization Techniques-Implementation and Performance Considerations-Variations on the Hopfield Network-A Stochastic Version of the Hopfield Network:
	UNIT III: The Boltzmann Machine-A Stochastic Version of the Binary Associative Memory: Restricted Boltzmann Machines-Competitive Learning and Self-Organizing Maps-Neural Network Modifications and Applications-Cellular Neural Networks and the Future of Massively Parallel Computation
	UNIT IV: Introduction to Machine Learning Techniques: Types of learning, hypothesis space and inductive bias, evaluation, cross-validation. Linear regression, Decision trees, overfitting.
	UNIT V: Support Vector Machine, Kernel function and Kernel SVM. Neural network: Perceptron, multilayer network, backpropagation, introduction to deep neural network.
Extended Professional Component	Questions related to the above topics, from various competitive examinations UPSC /TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	1. Raul Rojas, Neural Networks - A Systematic Introduction, Springer-Verlag, Berlin, NewYork,1996. 2. Koch, Christof, Biophysics of Computation: Information Processing in Single Neurons, Oxford University Press, 2004.
Reference Books	1. G. Dreyfus, Neural Networks Methodology and Applications, Springer, Berlin, Heidelberg, 2004. 2. James A. Freeman David M. Skapura, Neural Networks Algorithms, Applications, and Programming Techniques, Addison-Wesley Publishing Company, New York, 1991.
Website and e-Learning Source	1. https://nptel.ac.in/courses/117105084 2. https://www.digimat.in/nptel/courses/video/127105006/L01.html 3. https://www.youtube.com/watch?v=NeMAxhDvSak&list=PLgMDNELGJ1CZn1399dV7_U4VBNJflRsua 4. https://www.youtube.com/watch?v=QlhHqMnd9Wo

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO 1: Learn different types of neural networks and different types of learning models

CLO 2: Determine the mathematical foundations of neural network models

CLO 3: Implement of neural networks using training algorithms such as the feed-forward, back-propagation algorithm

CLO 4: Design neural networks for practical purposes

CLO 5: Build neural networks for practical purposes

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CLO 1	3	3	3	3	2	2	3	3	2	3
CLO 2	3	2	2	3	2	2	3	3	2	3
CLO 3	3	3	3	3	3	3	3	3	3	3
CLO 4	2	2	2	2	2	2	2	2	2	3
CLO 5	3	3	3	3	3	3	3	3	2	2

CO-PO-PSO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO 1	3	3	3	3	2	2	3	2	2	2
CLO 2	3	2	3	2	3	2	3	2	3	2
CLO 3	3	3	3	3	3	1	3	3	3	3
CLO 4	3	3	3	3	3	3	3	3	3	3
CLO 5	2	2	2	2	2	2	3	2	2	2

Level of correlation: 3-High, **2**-Medium, **1**-Low

Semester	Course Code	Title of the Course	Category	Hours/Week	L	T	P	C
II		**FINANCIAL MATHEMATICS**	**Group D Elective**	**4**	**3**	**1**	**-**	**3**

Course Objective

1. To recall fundamentals of Probability theory and understand the geometric Brownian motion
2. To understand the Arbitration Theorem and the Black-Schole's Theorem in detail.

Course Outcomes (Cos)

Course Outcome No.	Course Outcome	Knowledge Level Upto
CO1	Understanding probability theory and analyze the Geometric Brownian Motion	**K2,K4**
CO2	Knowledge of Interest Rate and making fair present value analysis	**K4**
CO3	Examine pricing contracts by understanding and using Arbitrage	**K4**

CO4	Understanding Arbitrage theorem with various examples	**K3,K4**
CO5	Derive the Black-Schole's formula	**K3**
K1=Remember,K2=Understand, K3=Apply,K4=Analyze,K5=Evaluate,K6= Create		

Financial Mathematics	
Unit I	Basic Probability Theory – Geometric Brownian Motion
Unit II	Interest Rate and Present Value Analysis
Unit III	Pricing Contracts via Arbitrage
Unit IV	The Arbitrage Theorem
Unit V	The Black-Scholes Formula

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**
CO 1	3	3	3	3	2	2	3	3	2	3
CO 2	3	2	2	3	2	2	3	3	2	3
CO 3	3	3	3	3	3	3	3	3	3	3
CO 4	2	2	2	2	2	2	2	2	2	3
CO 5	3	3	2	2	3	3	2	2	3	3

CO-PO-PSO Mapping

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO 1	3	3	3	3	3	3	3	2	2	2
CO 2	3	2	3	2	3	3	3	2	3	2
CO 3	3	3	3	3	3	3	3	3	3	3
CO 4	3	3	3	3	3	3	3	3	3	3
CO 5	2	2	2	2	3	3	3	2	2	2

Level of correlation: 3-High, **2**-Medium, **1**-Low

Text Book: Sheldon M. Ross, An Introduction to Mathematical Finance : Options and Other Topics, Cambridge University Press, 1999.

Further Readings:

1. Sheldon M. Ross, An Elementary Introduction to Mathematical Finance, Cambridge University Press, 2011.
2. I. Karatzas and S.E.Shreve, Methods of Mathematical Finance, Springer, 1998.

Semester	Course Code	Title of the Course	Category	Hours / Week	L	T	P	C
II		**MATHEMATICAL PYTHON**	**Group D Elective**	**4**	**3**	**1**	**-**	**3**

Course Objectives:

1. Understand the basic components of computer programming using the Pythonlanguage.
2. Demonstrate significant experience with the Python program developmentenvironment.
3. To learn and know the concepts of file handling, exception handling and databaseconnectivity.

Course Outcomes (COs): On completion of this course the students will be able to

Course Outcome No.	Course Outcome	Knowledge Level Upto
CO1	Develop algorithmic solutions to simple computationalproblems	**K3**
CO2	Read, write, execute by hand simple Python programs.	**K1, K3 & K6**
CO3	Represent compound data using Python lists, tuples,and dictionaries.	**K2**
CO4	Design and implement a program to solve a real worldproblem	**K6**
CO5	Use Python lists, tuples, dictionaries for representing compound data	**K3**
K1=Remember, K2=Understand, K3=Apply, K4=Analyze, K5=Evaluate, K6=Create		

Course Outline:

Unit 1: Introduction to Python - Why Python - Installing in various Operating Systems - Executing Python Programs - Basic Programming concepts - Variables, expressions and statements - Input/ Output –Operators.

Unit 2: Conditions - Functions - Arguments - Return values - Iteration - Loops - Strings -Data Structures - Lists - Dictionaries - Tuples - Sequences - Exception Handling.

Unit 3: File Handling - Modules - Regular Expressions - Text handling - Object Oriented Programming - Classes - Objects - Inheritance - Overloading – Polymorphism.

Unit 4: Introduction to Graphics programming - Introduction to GTK - PyGTK - Developing GUI applications using pyGTK - Scientific Programming using NumPy / SciPy - Image Processing - Processing multimedia files -Network Programming - Web services using SOAP, Introduction to Graphics programming – PyGame.

Unit 5: Introduction to Version Control Systems - Subversion/Git, Writing Unit Tests, Creating Documentation, Contributing to Open Source Projects. **(9 hours)**

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	3	3	3	2	2	3	3	2	3
CO 2	3	2	2	3	2	2	3	3	2	3
CO 3	3	3	3	3	3	3	3	3	3	3
CO 4	3	2	3	2	3	2	3	2	3	2
CO 5	3	3	2	2	3	3	2	2	3	3

CO-PO-PSO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	3	3	3	3	3	3	3	3	3	2
CO 2	3	2	3	2	3	3	3	2	3	2
CO 3	3	3	3	3	3	3	3	2	3	3
CO 4	3	3	3	3	3	3	3	2	3	3
CO 5	2	2	2	2	3	3	3	3	3	2

Level of correlation: 3-High, **2**-Medium, **1**-Low

Text Book:

Allen B. Downey, Think Python: How to Think Like a Computer Scientist (Second Edition), Shroff /O'Reilly Publishers, 2016 (http://greenteapress.com/wp/think- python/)

Reference Books:

1. Charles Dierbach, Introduction to Computer Science using Python: A Computational Problem-Solving Focus, Wiley India Edition, 2013
2. John V Guttag, Introduction to Computation and Programming Using Python', Revisedand expanded Edition, MIT Press, 2013.
3. Kenneth A. Lambert, Fundamentals of Python: First Programs, CENGAGE Learning,2012.

Webliography:

1. https://nptel.ac.in/courses/106/106/106106182/
2. https://nptel.ac.in/courses/106/106/106106145/

Semester	Course Code	Title of the Course	Category	Hours/ Week	L	T	P	C
II		**Resource Management Techniques**	**Group D Elective**	**4**	**3**	**1**	**-**	**3**

Course Objectives:

1. To understand the methodology of OR problem solving and formulate linear programming problem.
2. To know how project management techniques help in planning and scheduling a project
3. To know basics of network scheduling.

Course Outcomes (COs):

On completion of this course the students will be able to

Course Outcome No.	Course Outcome	Knowledge Level Upto
CO1	recognize the importance and value of Operations Research and linear programming in solving practical problems in industry .	**K1 & K2**
CO2	solve problems using simplex or dual simplex method	**K2, K3 & K4**
CO3	familiarize with Integer Programming Problems	**K4 & K5**
CO4	draw project networks for quantitative analysis of projects	**K3 & K6**
CO5	gain knowledge about resource analysis, allocation and scheduling	**K3 & K5**
K1=Remember, K2=Understand, K3=Apply, K4=Analyze, K5=Evaluate, K6= Create		

Course Outline:

Unit I: Linear Programming Problem- Introduction- Graphical solution method-General linear programming problem-canonical and standard forms of LPP- solutions of simultaneous linear equations- inverting a matrix using simplex method- fundamental properties of solutions –the computational procedure. (12 hrs)

Unit II Duality in Linear Programming –Introduction – General Primal-Dual Pair-Formulating a dual problem-Primal-dual pair in matrix form-Duality theorems-Duality and Simplex methodb-Dual-Simplex method. (12 hrs)

Unit III: Integer Programming: Introduction- Pure and mixed Integer Programming problems-Gomory's All-IPP method-construction of Gomory's constraints-Fractional cut-method-All Integer LPP and Mixed integer LPP-Branch and Bound method. (12 hrs)

Unit IV: Network scheduling by PERT/CPM: Introduction-Network-Basic Components-Logical sequencing- Rules of network construction – critical path analysis- Probability considerations in PERT- Distinction between PERT and CPM. (12 hrs)

Unit V: Resource analysis in network scheduling :Introduction-Project cost-Time – cost optimization algorithm-Linear Programming formulation –updating –Resource allocation and scheduling –MOST-GERT-Procedure Planning-LOB (12 hrs)

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	3	3	3	2	2	3	3	2	3
CO 2	3	3	1	2	2	2	3	3	2	3
CO 3	3	3	2	1	3	3	3	3	3	3
CO 4	3	3	1	2	3	2	3	2	3	2
CO 5	3	3	3	3	3	3	2	2	3	3

CO-PO-PSO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	3	3	3	3	2	3	3	3	3	2
CO 2	3	2	3	3	2	3	3	2	3	2
CO 3	3	3	3	3	2	3	3	2	3	3
CO 4	3	3	3	3	2	3	3	2	3	3
CO 5	2	2	3	3	2	3	3	3	3	2

Level of correlation: 3-High, **2**-Medium, **1**-Low

Text Book:

Kani Swarup, P.K.Gupta and Man Mohan,Operations Research- Sultan Chand and Sons,NewDelhi. Chapters 3(3.1.3.2,3.4,3.5), 4(4.2,4.3,4.6.4.7), 5(5.1-5.5,5.7,5.9), 7(7.1-7.7),25(25.1 -25.4, 25.6-25.8) and 26.

Reference Books:

1. F S Hiller and G J Leiberman, Introduction to Operations Research, Mc-Graw Hill Higher Education

2. H. A.Taha, Operations Research – An Introduction, Pearson Publications.

3. N K Tiwari, Operations Research, PHI Learning Private Limited.

Webliography:

1. *https://nptel.ac.in* › courses
2. *https://www.ieor.columbia.edu* ›

Semester III : Elective V

Elective V to be chosen from Group E.

Group E: (PM/AP/IC/ITC)

1. **Algebraic Number Theory**
2. **Fluid Dynamics**
3. **Stochastic Processes**
4. **Combinatorial Theory**

<table>
<tr><td colspan="2">Title of the course</td><td colspan="7">ALGEBRAIC NUMBER THEORY</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="7"></td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Group E Elective</td><td>Year</td><td>II</td><td rowspan="2">Credits 3</td><td rowspan="2">Hrs: 4/0/0</td><td>Course code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>III</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="7">Algebra and Linear Algebra</td></tr>
<tr><td colspan="2">Course Outline</td><td colspan="7">UNIT – I : Algebraic back ground : Rings and Fields –Factorization of Polynomials – Field extensions – Symmetric polynomials – Modules – Free Abelian groups. Chapter 1 : Sections – 1.1 to 1.6</td></tr>
<tr><td colspan="2"></td><td colspan="7">UNIT – II : Algebraic numbers – Conjugate and Discriminant – Algebraic integers. Chapter 2 : Sections – 2.1 – 2.3</td></tr>
<tr><td colspan="2"></td><td colspan="7">UNIT – III : Integral bases – Norms and traces – Rings of integers. Chapter 2 : Sections – 2.4 to 2.6</td></tr>
<tr><td colspan="2"></td><td colspan="7">UNIT – IV : Quadratic fields – Cyclotomic fields
Chapter 3 : Sections – 3.1 – 3.2</td></tr>
<tr><td colspan="2"></td><td colspan="7">UNIT – V : Historical background – trivial factorization – factorization into irreducible. Chapter 4 : Sections – 4.1 – 4.3</td></tr>
<tr><td colspan="2">Recommended Text</td><td colspan="7">I.Stewart and D.Tall. Algebraic number theory and Fermat’s
Last theorem (3rd edition) A.K Peters Ltd,Natrick, Mass. 2002</td></tr>
<tr><td colspan="2">Reference Books</td><td colspan="7">1. Z. I. Borevic and I.R.Safarevic, Number theory,Academic Press, NY, 1966.
2. J.W.S.cassels and A.Frohlich, Algebraic , Numbertheory, Academic Press, New York, 1967.
3. P. Ribenboim, Algebraic numbers, Wiley, New York,1972.
4. P.Samuel, Algebraic Theory of Numbers, Houghton Mifflin company, Boston, 1970</td></tr>
</table>

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO1: Explain the basic concepts and applications of Algebraic Number theory.

CLO2: Compare and contrast different supervised Algebraic Number theory. Explain the approaches of Algebraic Number theory.

CLO3:Discuss Algebraic Number theory including topics, branches, and applications.

CLO4: Explain the significance of Quadratic fields in the Algebraic Number theory.

CLO5: Illustrate how Algebraic Number theory works in Historical background (basics only).

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CLO 1	3	3	3	3	2	2	3	3	2	3
CLO 2	3	3	1	2	2	2	3	3	2	3
CLO 3	3	3	2	1	3	3	3	3	3	3
CLO 4	3	3	1	2	3	2	3	2	3	2
CLO 5	3	3	3	3	3	3	3	3	3	3

CO-PO-PSO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO 1	3	3	3	3	2	3	3	3	3	2
CLO 2	3	2	3	3	2	3	3	2	3	2
CLO 3	3	3	3	3	2	3	3	2	3	3
CLO 4	3	3	3	3	2	3	3	2	3	3
CLO 5	2	2	3	3	2	3	3	3	3	2

Level of correlation: 3-High, **2**-Medium, **1**-Low

Semester	Course Code	Title of the Course	Category	Hours/ Week	L	T	P	C
III		**FLUID DYNAMICS**	**Group E Elective**	**4**	**4**	**0**	**-**	**3**

Course Objective

1. To provide fundamental knowledge on C++ programming to formulate algorithm to solve numerical problems
2. To understand the concept of error and the approximate solutions of the Mathematical problems
3. To compute the numerical solutions to the given Mathematical equations both manually and via programming

Course Outcomes (Cos)

Course Outcome No.	Course Outcome	Knowledge Level Upto
CO1	Analyzing the Kinematic motion of fluid	**K4**
CO2	Exploring Mathematical equations of motion of fluid	**K3,K4**
CO3	Understanding and analyzing fluid flow involving axial symmetry	**K2,K4**
CO4	Examine fluid flow in three dimension	**K4**
CO5	Deriving Navier-Stoke's equation and solving problems involving viscous flow in tubes of uniform cross section	**K3**
K1=Remember,K2=Understand,K3=Apply,K4=Analyze,K5=Evaluate,K6= Create		

Fluid Dynamics	
Unit I	Kinematics of fluids in motion
Unit II	Equations of motion of fluid
Unit III	Some flows involving axial symmetry
Unit IV	Some three dimensional flow
Unit V	The Navier-Stoke's equation of motion of viscous fluid – Some solvable problems in viscous flow – Steady viscous flow in tubes of uniform cross section

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**
CO 1	3	3	3	3	2	2	3	3	2	3
CO 2	3	2	3	2	3	2	3	2	3	2
CO 3	3	3	2	1	3	3	3	3	3	3
CO 4	3	3	1	2	3	2	3	2	3	2
CO 5	3	3	3	3	3	3	3	3	3	3

CO-PO-PSO Mapping

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO 1	3	3	3	3	2	3	3	3	3	2
CO 2	3	2	3	3	2	3	3	2	3	2
CO 3	3	3	3	3	2	3	3	2	3	3
CO 4	3	3	3	3	2	3	3	2	3	3
CO 5	3	3	3	3	3	2	2	2	2	2

Level of correlation: 3-High, **2**-Medium, **1**-Low

Text Books :
1. F. Chorlton, Textbook of Fluid Dynamics, CBS Publishers, 2018 (Chapter 2,3,4,8(8.9 to 8.11)

Further Readings :
1. M.D. Raisinghania, Fluid Dynamics, S. Chand Publication, 2013
2. G.K. Batchelor, An Introduction to Fluid Dynamics, Cambridge University Press, 2002
3. S.W. Yuan, Foundations of Fluid Mechanics, Pearson India, 1967

Semester	Course Code	Title of the Course	Category	Hours/ Week	L	T	P	C
III		**STOCHASTIC PROCESSES**	**Group E Elective**	**4**	**4**	**-**	**-**	**3**

Course Objectives:

1. To acquire the skill of advanced level of mathematical sophistication and enhancing the horizons of knowledge.
2. To acquire understanding of applicability of different concepts of stochastic processes on some physical situation.
3. To familiarize the students with the use of stochastic models in different areas.

Course Outcomes (COs):

On completion of this course the students will be able to

Course Outcome No.	Course Outcome	Knowledge Level Upto
CO1	understand knowledge related to the problems of uncertainty.	**K2**
CO2	Create knowledge for studying advanced courses in this area	**K6**
CO3	Analyze problems and to solve widely varied problems.	**K4**
K1=Remember,K2=Understand, K3=Apply,K4=Analyze,K5=Evaluate,K6= Create		

Course Outline:

Unit I : Stochastic Processes: Introduction, Specification of Stochastic Processes, Stationary Process, Martingales. Markov Chains: Definition and Examples, Higher Transition Probabilities, Generalization of independent Bernoulli Trials: Sequence of Chain Dependent Trials, Classification of States and Chains. (12 hrs)

Unit II : More on Markov Chains: Determination of Higher Transition Probabilities, Stability of a Markov System, Markov Chain with Denumerable Number of States, Reducible Chains. **(12 hrs)**

Unit III : Markov Processes with Discrete State Space: Poisson Process and its Extensions: Poisson Process, Poisson Process and Related Distributions, Generalization of Poisson Process, Birth and Death Process, Markov Process with Discrete State Space (Continuous Time Markov Chains). **(12 hrs)**

Unit IV: Markov Chains and Markov Processes with Continuous State Space: Markov Chains with Continuous State Space, Introduction, Brownian Motion, Wiener Process, Differential Equations for a Wiener Process, Kolmogorov Equations, First Passage Time Distribution for Wiener Process. **(12 hrs)**

Unit V : Renewal Process, Renewal Processes in Continuous Time, Renewal Equation, Stopping time: Wald's Equation, Renewal Theorems, Delayed and Equilibrium Renewal Processes. **(12 hrs)**

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	3	3	3	3	2	3	3	2	3
CO 2	3	2	3	3	2	2	3	2	3	2
CO 3	3	3	2	3	2	3	3	3	3	3
CO 4	3	3	1	3	2	2	3	2	3	2
CO 5	3	3	3	3	2	3	3	3	3	3

CO-PO-PSO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	3	3	3	3	2	3	2	3	3	2
CO 2	3	2	3	3	2	2	3	2	3	2
CO 3	3	3	3	3	2	2	3	2	3	3
CO 4	3	3	3	3	2	2	3	2	3	3
CO 5	3	3	3	3	3	3	2	2	2	2

Level of correlation: 3-High, **2**-Medium, **1**-Low

Text Book:

1. Medhi.J., (1994) ,Stochastic Processes, Second Edition, New Age International (P) Limited, Publishers, New Delhi.
   Unit-I Chapter 2: Sections 1 to 4 and Chapter 3: Sections 1 to 4.
   Unit-II Chapter 3: Sections 5,6,8 and 9.
   Unit-III Chapter 4: Sections 1 to 5.
   Unit-IV Chapter 3: Section 11 Chapter 5: Sections 1 to 5.
   Unit-V Chapter 6: Sections 1 to 6.

Reference Books:

1. Karlin S. and Taylor H.M., (2011) A First Course in Stochastic Processes, Second Edition, Academic Press ,New York.
2. Ross, S.M., (2008) Stochastic Processes, Second Edition, Wiley India Pvt., Ltd., New Delhi.

Semester	Course Code	Title of the Course	Category	Hours/ Week	L	T	P	C
III		**COMBINATORIAL THEORY**	**Group E Elective**	**4**	**4**	**-**	**-**	**3**

Course Objectives:

1. This course acquaints the students with the concepts of permutations and combinatorics, generating functions, recurrence relations, the principle of inclusion and exclusion and Polya's theory of counting.
2. It develops skills to apply the techniques of combinations and permutations for counting the number of certain configurations.
3. It makes the students familiar with fundamental combinatorial structures that naturallyappear in various other fields of Mathematics and Computer Science.

Course Outcomes (CO): On completion of this course the students will be able to

Course Outcome No.	Course Outcome	KnowledgeLevel Upto
CO1	Use formulas for counting basic combinatorial outcomes to construct solutions to complete combinatorial enumeration problems	**K1, K3**
CO2	Apply counting strategies to solve discrete probability problems	**K3**
CO3	Use specialized techniques to solve combinatorial enumeration problems: generating functions; recurrence relations; inclusion-exclusion principle	**K3,K5**
CO4	Understand the concepts of permutations with restrictions on relative positions and the rook polynomials	**K2**
CO5	Enumerate configuration using Polya's theory	**K5**
K1=Remember,K2=Understand, K3=Apply,K4=Analyze,K5=Evaluate,K6= Create		

Course Outline:

Unit I : Permutations and Combinations - rule of sum and product - distributions of distinct objects - Distributions of non-distinct objects. (12 hrs)

Unit II : Generating functions for combinations - Enumerators for permutations - Distributions of distinct objects into non-distinctcells - partitions of integers - Ferrers graph – elementary relations. (12 hrs)

Unit III: Recurrence relations - Linear recurrence relations with constant co-efficients -solution by the technique of generating functions -a special class of non-linear difference equation – recurrence relations with two indices. (12 hrs)

Unit IV: The principle of inclusion and exclusion - general formula - derangements - rook polynomials - permutations with forbidden positions. (12 hrs)

Unit V : Polya's theory of counting Equivalence classes under a permutation groups - Equivalence classes of functions - Weightsand inventories of functions - Polya's fundamental theorem - Generalization of Polya's theorem. (12 hrs)

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	3	2	3	3	2	3	3	-	3
CO 2	3	2	2	3	2	2	3	2	-	2
CO 3	3	3	2	3	2	3	3	3	-	3
CO 4	3	3	2	3	2	2	3	2	-	2
CO 5	3	3	2	3	2	3	3	3	-	3

CO-PO-PSO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	3	3	3	3	2	3	2	3	3	2
CO 2	3	2	3	3	2	3	2	-	3	2
CO 3	3	3	3	3	2	3	2	-	3	3
CO 4	3	3	3	3	2	3	2	-	3	3
CO 5	3	3	3	3	3	3	2	3	2	2

Level of correlation: 3-High, **2**-Medium, **1**-Low

Text Book:

C.L. Liu, Introduction to Combinatorial Mathematics, McGraw Hill (1968)

Unit I to V: Chapters 1 to 5.

Reference Books :

1. M. Aigner, A Course in Enumeration, Springer-Verlag, Heidelberg, 2007.

2. R.P. Stanley, Enumerative Combinatorics, Volume I, 2nd Edition, Cambridge Studies in Advanced Mathematics , Cambridge University Press, 1997.

3. Miklos Bona, A Walk through Combinatorics, World Scientific Publishing Company, 2002.

Webliography:

https://nptel.ac.in/courses/111/106/111106155/

Non Major Elective Courses (NME) Semesters II and III

1. **Mathematics for Competitive Examinations**
2. **Discrete Mathematics**
3. **Numerical Methods**
4. **Introduction To Mathematical Biology**

Title of the Course	**MATHEMATICS FOR COMPETITIVE EXAMINATIONS**					
Paper Number						
Category	NME	**Semester**	II or III	**Credits 2**	Hrs 4 3/1/0	**Course Code**
Semester	II or III					
Instructional Hours per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
-	3	1		4		
Pre-requisite	12th Standard Mathematics					
Objectives of the Course	To learn the techniques for solving aptitude problems and to enable the students prepare themselves for various competitive examinations.					
Course Outline						
UNIT-I: Problems on Ages – Percentage						
Unit II: Profit and Loss – Ratio and Proportion.						
Unit III: Time and Work – Simple Interest.						
Unit IV: Compound Interest – Calendar.						
Unit V: Stocks and Shares – Bankers' Discount.						
Extended Professional Component	Questions related to the above topics, from various competitive examinations UPSC / TNPSC / others to be solved(To be discussed during the Tutorial hour)					
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill					

Text Book	Quantitative Aptitude by R.S. Aggarwal (Edition 1996), Chapters 8, 10 to 12, 15, 21, 22, 27, 29 and 31.
Reference Text	Rajesh Verma,Fast track Objective arithmetic, Arihant Publications India Limited Fourth Edition, 2018.
Website and e-Learning Source	https://nptel.ac.in

Semester	Course Code	Title of the Course	Category	Hours/ Week	L	T	P	C
II or III		**DISCRETE MATHEMATICS**	**NME**	**4**	**3**	**1**	**-**	**2**

Course Objective

1. To provide strong foundation on Logic, Mathematical Induction and Counting Principle
2. To gain knowledge on relations and partially ordered sets
3. To understand the concept of Boolean Spaces

Course Outcomes (Cos)

Course Outcome No.	Course Outcome	Knowledge Level Upto
CO1	Understand and Analyze the given Mathematical statements	**K2, K4**
CO2	Apply the principle of Mathematical Induction to analysis the validity of various Mathematical statements.	**K3**
CO3	Understand and apply the Counting Principles to count number of elements in the given sets	**K2, K4**
CO4	Introducing and analyzing the notion of order in the given set and creating partially ordered sets	**K4**
CO5	Developing basic properties of Boolean Algebra	**K6**
K1=Remember,K2=Understand, K3=Apply,K4=Analyze,K5=Evaluate,K6= Create		

Discrete Mathematics	
Unit I	The Foundations : Logics and Proofs
Unit II	Induction and Recursion
Unit III	Counting
Unit IV	Relations
Unit V	Boolean Algebra

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	3	2	3	3	2	3	3	-	3
CO 2	3	2	2	3	2	2	3	2	-	2
CO 3	3	3	2	3	2	3	3	3	-	3
CO 4	3	3	2	3	2	2	3	2	-	2
CO 5	3	3	2	3	2	3	3	3	-	3

CO-PO-PSO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	3	3	3	3	2	3	2	3	-	2
CO 2	3	2	3	3	2	3	2	3	-	2
CO 3	3	3	3	3	2	3	2	3	-	3
CO 4	3	3	3	3	2	3	2	3	-	3
CO 5	3	3	3	3	3	3	2	3	-	2

Level of correlation: 3-High, **2**-Medium, **1**-Low

Text Books :

1. Kenneth H. Rosen, Discrete Mathematics and Its Applications, McGraw Hill Publication, 2019 (Chapter 1,5,6,9,12)

Further Readings :

1. J.P. Tremblay, R. Manohar, Discrete mathematical structures with applications to computer science, Tata-McGraw Hill Education Pvt.Ltd.
2. T. Sengadir, Discrete Mathematics and Combinatorics, Pearson India.
3. Ralph P. Girmaldi, Discrete and Combinatorial Mathematics, Addison-Wesley, 1993

Semester	Course Code	Title of the Course	Category	Hours/ Week	L	T	P	C
II or III		NUMERICAL METHODS	NME	4	3	1	-	2

Course Objectives:

1. The aim of this course is to develop the skills in solving algebraic, transcendental, differential and integral equations numerically prerequisite.
2. To perform an error analysis for various numerical methods and derive appropriate numerical methods to solve definite integrals.
3. The outcome of the course is enabling the students to get numerical (approximate) solutions wherever analytic (exact) solutions are not possible.

Course Outcomes (COs):

On completion of this course the students will be able to

Course Outcome No.	Course Outcome	Knowledge Level Upto
CO1	Solve algebraic and transcendental equations using appropriate numerical methods and approximate a function using appropriate numerical methods.	**K2**
CO2	Derive numerical methods for various mathematical operations and tasks such as interpolation, differentiation, integration and the solution of linear and nonlinear equations	**K3**
CO3	Analyze and evaluate the accuracy of common numerical methods.	**K4**
CO4	Evaluate and interpret results on real life problems using appropriate numerical techniques.	**K5**
CO5	Solve algebraic and transcendental equations using appropriate numerical methods and approximate a function using appropriate numerical methods.	**K2**
K1=Remember, K2=Understand, K3=Apply, K4=Analyze, K5=Evaluate, K6= Create		

Course Outline:

Unit I: Introduction: Errors in numerical calculations – Mathematical preliminaries – Solution of Algebraic and Transcendental equations: The Bisection method – The method of false position.

Unit II: Newton-Raphson method – Introduction – The Iteration method – Muller's method – Graffes' root squaring method

Unit III: Interpolation: Newton's Formulae for interpolation – Central difference interpolation formulae.

Unit IV: Numerical Differentiation and integration: Numerical differentiation – Numerical integration

Unit V: Matrices and Linear systems of equations: Solution of Linear systems – Iterative methods - The Eigen value problem

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	3	2	3	3	2	3	3	2	3
CO 2	3	2	2	3	2	2	3	2	2	2
CO 3	3	2	2	3	2	3	3	3	2	3
CO 4	3	2	2	3	2	2	3	2	2	2
CO 5	3	3	2	3	2	3	3	3	2	3

CO-PO-PSO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	3	3	3	3	2	3	2	3	1	2
CO 2	3	2	1	1	1	3	2	3	1	2
CO 3	3	3	1	1	1	3	2	3	1	3
CO 4	3	3	1	1	2	3	2	3	1	3
CO 5	3	3	3	3	3	3	2	3	1	2

Level of correlation: 3-High, **2**-Medium, **1**-Low

Text Book: Introductory Method of Numerical Analysis (Third Edition) by S.S. Sastry, Sections 1.3, 2.1 to 2.5, 2.7, 2.8, 3.6, 3.7, 5.2, 5.4(5.4.1 to 5.4.3 only), 6.4 and 6.5

Reference Books:

1. M. K. Jain, S. R. K. Iyengar, R. K. Jain, Numerical Methods for Scientific and Engineering Computation, Second Edition, Wiley Eastern Ltd, New Delhi.
2. D. Vaughan Griffiths, I. M. Smith, Numerical Methods for Engineers, Chapman &Hall, CRC, 2006.
3. V. N. Vedamurthy, S. N. Iyengar Numerical Methods, Vikas Publishing house PVT. Ltd 1998.

Webliography:

1. https://nptel.ac.in/courses/111/107/111107105/
2. https://nptel.ac.in/courses/127/106/127106019/
3. https://nptel.ac.in/courses/111/107/111107062/

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">INTRODUCTION TO MATHEMATICAL BIOLOGY</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">NME</td><td>Year</td><td>I or II</td><td rowspan="2">Credits</td><td rowspan="2">2</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>II or III</td></tr>
<tr><td colspan="2" rowspan="2"></td><td colspan="2">Lecture</td><td>Tutorial</td><td>Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td colspan="2">3</td><td>1</td><td>--</td><td colspan="2">4</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">Basic Mathematics</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">1. The focus of the course is on scientific study of normal functions in living systems. The emphasis is on exposure to nonlinear differential equations with examples such as heartbeat, chemical reactions and nerve impulse transmission.
2. The basic concepts of the probability to understand molecular evolution and genetics have also been applied.</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="6">UNIT I: Cell growth-Exponential growth and Decay – Determination of growth or decay rates- The method of least squares – Nutrient Uptake by a cell –Inhomogeneous Differential equations.</td></tr>
<tr><td colspan="6">UNIT II: Growth of a Microbial colony – Growth in a Chemo stat – Interacting Populations – Mutation and Reversion in Bacterial growth.</td></tr>
<tr><td colspan="6">UNIT III: Enzyme Kinematics: The Michaelis – Menton Theory – Enzyme Substrate – Inhibitor system – Cooperative dimmer – Allosteric enzymes – Other alloseteric theories.</td></tr>
<tr><td colspan="6">UNITIV: The Cooperative dimmer – Allosteric enzymes – Other alloseteric theories.</td></tr>
<tr><td colspan="6">UNITV: Hemoglobin – Graph theory and Steady state Enzyme Kinetics – Enzyme – Substrate – Modifier system – Enzyme Substrate – Activator system.</td></tr>
<tr><td colspan="2">Extended Professional Component</td><td colspan="6">Questions related to the above topics, from various competitive examinations UPSC / TRB / TNPSC / others to be solved
(To be discussed during the Tutorial hour)</td></tr>
<tr><td colspan="2">Skills acquired from this course</td><td colspan="6">Knowledge, Professional Competency, Professional Communication and Transferrable Skill</td></tr>
<tr><td colspan="2">Recommended Text</td><td colspan="6">S. I. Rubinow, Introduction Mathematical Biology, Dover publications, New York, 1975.
Chapter I and Chapter 2 (Sections 2.1,2.3, to 2.11).</td></tr>
<tr><td colspan="2">Reference Books</td><td colspan="6"></td></tr>
<tr><td colspan="2">Website and e-Learning Source</td><td colspan="6"></td></tr>
</table>

Course Learning Outcome (for Mapping with POs and PSOs)
Students will be able to
CLO 1: analysis and interpretation of bio mathematical models such as population growth, cell division, and predator-prey models.
CLO 2: apply the basic concepts of probability to molecular evolution and genetics.
CLO 3: Identify and appreciate the unifying influence of mathematical modelling in different disciplines
CLO 4: Explain Allosteric enzymes
CLO 5:Analyze and translate a real-world problem into a mathematical problem

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	3	2	3	3	2	3	3	2	3
CO 2	3	2	2	3	2	2	3	2	2	2
CO 3	3	2	2	3	2	3	3	3	2	3
CO 4	3	2	2	3	2	2	3	2	2	2
CO 5	3	3	2	3	2	3	3	3	2	3

CO-PO-PSO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	3	3	3	3	2	3	2	3	1	2
CO 2	3	2	1	1	1	3	2	3	1	2
CO 3	3	3	1	1	1	3	2	3	1	3
CO 4	3	3	1	1	2	3	2	3	1	3
CO 5	3	3	3	3	3	3	2	3	1	2

Level of correlation: 3-High, **2**-Medium, **1**-Low

SEMESTER-IV 4.4. Elective VI (Industry/Entrepreneurship)

Semester	Course Code	Title of the Course	Category	Hours/ Week	L	T	P	C
IV		**ADVANCED LATEX PRACTICAL**	**Elective VI**	**4**	**-**	**-**	**4**	**3**

Course objectives:
The objectives of this course are

1. To make the students to become entrepreneur by setting up a small DTP shop.
2. To make the students experts in preparing high quality mathematics document, power point presentation, different types of difficult diagrams by writing through LATEX programming.
3. To make the students experts in production of technical and scientific documentation.

List of LATEX Programs to be coved under this course;

1. Introduction to LATEX- How to prepare a LATEX input file? - How to compile a LATEX input file? - LATEX syntax - Commands - Environments – Packages- Keyboard characters in LATEX
2. Fonts Selection - Text-mode fonts- Math-mode fonts - colored fonts
3. Texts Formatting - Sectional units - Labeling and referring numbered items - Quoted texts- New lines and paragraphs - Creating and filling blank space - Producing dashes within texts- Foot notes.
4. Listing Texts- Numbered listing through enumerate environment - Unnumbered listing through itemize environment- Listing with user-defined labels through description environment, Nesting different listing environments.
5. Tabbing Texts.
6. Table Preparation- Table through tabular environment- Table through tabularx environment .- Vertical positioning of tables- Merging rows and columns of tables- Tables in multi-column documents - Tables at the end of a document.
7. Figure Insertion - Commands and environment for inserting figures .- Inserting simple figures- Sub-numbering a group of figures -Figures in multi-column documents - Figures at the end of a document.
8. Drawing Mathematical Figures using supporting package LATEXCARD.
9. Equation Writing - Basic notations and delimiters - Mathematical operators - Mathematical expressions in text-mode - Simple equations - Array of equations
10. Bibliography with BIBTEX - Preparation of BIBTEX compatible reference database - Standard bibliographic styles of LATEX -Compiling BIBTEX based LATEX input file
11. Article Preparation - List of authors - Title and abstract on separate pages - Articles in multiple columns
12. Thesis preparation - Template of a thesis -Compilation of thesis
13. Slide Preparation - Frames in presentation - Sectional units in presentation - Presentation structure - Title page - Appearance of a presentation (BEAMER themes)

Recommended Text

1. H. Kopka and P.W. Daly, *A Guide to LaTeX*, Addison-Wesley,2003.

Reference Book

1. E. Krishnan, *LaTeX TUTORIALS* — A Primer, Indian TEX Users Group, 2003
2. S. Kottwitz, LaTeX Beginner's Guide**,** Packt Publishing Ltd.32 Lincoln Road Old on Birmingham.

Course Outcomes

CO No.	Upon completion of the course, the students will be able to	PSOs Addressed	Cognitive Level
CO-1	Understand the basic structures of an article.	1,4,5	Understanding
CO-2	Apply their skills to class files of some journals.	1,2,4	Applying
CO-3	Analyze the page styles using the text in boxes.	1,3	Analyzing
CO-4	Explain the concepts to write documents containing mathematical formulas.	1,4	Evaluating
CO-5	Discuss the concepts as how to draw graphs.	1,3,5	Creating

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	3	2	3	3	2	3	3	2	3
CO 2	3	2	2	3	2	2	2	1	2	2
CO 3	3	2	2	3	2	1	2	2	2	3
CO 4	3	2	2	3	2	2	2	2	2	2
CO 5	3	3	2	3	2	3	3	3	2	3

CO-PO-PSO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	3	3	3	3	2	3	2	3	1	2
CO 2	3	2	2	2	2	3	2	3	1	2
CO 3	3	3	2	2	2	3	2	3	1	3
CO 4	3	3	2	2	2	3	2	3	1	3
CO 5	3	3	3	3	3	3	2	3	1	2

Level of correlation: **3**-High, **2**-Medium, **1**-Low

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