MANONMANIAM SUNDARANAR UNIVERSITY, TIRUNELVELI

M.Sc. MATHEMATICS

SYLLABUS

For Affiliated Colleges

(Based on TANSCHE Guidelines)

(For those who joined from 2023-2024 onwards)

TABLE OF CONTENT

PREAMBLE

In pursuit of the Higher Education Department Policy Note 2022-23 Demand 20, Section 1.4, Tamil Nādu State Council for Higher Education took initiative to revamp the curriculum. On 27 July 2022, a meeting was convened by the Member-Secretary Dr. S. Krishnasamy enlightening the need of the hour to restructure the curriculum of both Under-graduate and Post-graduate programmes based on the speeches at the Tamil Nādu Legislative Assembly Budget meeting by the Honourable Higher Education Minister Dr K. Ponmudy and Honourable Finance Minister Dr. P. Thiagarajan. At present there are three different modes of imparting education in most of the educational institutions throughout the globe. Outcome Based Education, Problem Based Education, and Project Based Education.

Now our Honourable Higher Education Minister announced Industry Aligned Education. During discussion, the Member Secretary announced the importance of question papers and evaluation as envisaged by the Honourable Chief Secretary to Government Dr, V. IraiAnbu. This is very well embedded in Revised Bloom's Taxonomy.

Taxonomy forms three learning domains: the cognitive (knowledge), affective(attitude), and psychomotor (skill). This classification enables us to estimate the learning capabilities of students.

Briefly, it is aimed to restructure the curriculum as student-oriented, skill-based, and institution-industry-interaction curriculum with the various courses under
"Outcome Based Education with Problem Based Courses, Project Based Courses, and Industry Aligned Programmes" having revised Bloom's Taxonomy for evaluating students skills.
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 :

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 endeavours and contribute significantly to society.

PO9: Multicultural competence**:** Possess knowledge of the values and beliefs of multiple cultures and a global perspective.

PO10: 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.

PSO2: Entrepreneur**:** To create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skills 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 employability, ethical and innovative professionals to sustain in the dynamic business world.

PSO5: Contribution to the Society**:** To contribute to the development of the society by collaborating with stakeholders for mutual benefits.

LEARNING AND TEACHING ACTIVITIES

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
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%

TEACHING METHODOLOGIES

Traditional Teaching methods like Chalk and Board, Virtual Classroom, LCD projector, Smart Class, Video Conference, Guest Lectures.

Asking students to formulate a problem from a topic covered in a week's time

Assignment, Class Test, Slip test

Asking students to use state-of-the-art technologies/software to solve problems

Applications, Use of Mathematical software

Introducing students to applications before teaching the theory

Training students to engage in self-study without relying on faculty (for example – library and internet search, manual and handbook usage, etc.)

Library, Net Surfing, Manuals, NPTEL Course Materials published in the website

Other university websites.

FACULTY COURSE FILE STRUCTURE

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

PG PROGRAMME STRUCTURE

Semester–I	Credits	Hour	Semester-II	Credits	Hour	Semester-III	Credits	Hour	Semester–IV	Credits	Hour
1.1. Core-I	5	6	2.1. Core-IV	5	6	3.1. Core-VII	5	6	4.1. Core-XI	5	6
1.2. Core-II	5	6	2.2. Core-V	5	6	3.2. Core-VII	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	6	2.4.Discipline Centric Elective-III	3	4	3.4.Core – X (Industry Module)	4	6	4.4..Elective-VI (Industry Entrepreneurship) 20% Theory 80% Practical	3	4
1.5. Generic Elective-II	3	6	2.5. Generic Elective-IV	3	4	3.5. Discipline Centric Elective - V	3	3	4.5.Skill Enhancement Course -III Professional Competency Skill	2	4
			2.6. Skill Enhancement - 1	3	4	3.6.Skill Enhancement - II	2	3	4.6.Extension Activity	1	
						3.7.Internship/ Industrial Activity	2	-			
Total	**20**	**30**		**22**	**30**		**26**	**30**		**23**	**30**
									Total Credit Points	**91**	

M.Sc. MATHEMATICS PROGRAMME STRUCTURE

First Year

	Semester-I	Credit	Hours per week
Part - A	1.1. **CC-I** : Algebraic Structures	5	6
	1.2. **CC-II** : Real Analysis - I	5	6
	1.3. **CC-III** : Ordinary Differential Equations	4	6
	1.4. **Elective - I** (Choose any one) 1.4.1. Graph Theory and Applications 1.4.2. Formal Languages and Automata Theory 1.4.3. Algebraic Number Theory	3	6
	1.5. **Elective - II** (Choose any one) 1.5.1. Number Theory and Cryptography 1.5.2. Analytic Number Theory 1.5.3. Fuzzy Sets and Their Applications	3	6
	Total	**20**	**30**

	Semester-II	Credit	Hours per week
Part - A	2.1. **CC-IV** : Advanced Algebra	5	6
	2.2. **CC-V** : Real Analysis - II	5	6
	2.3. **CC-VI** : Partial Differential Equations	4	6
	2.4. **Elective - III** (Choose any one) 2.4.1. Algebraic Topology 2.4.2. Mathematical Statistics 2.4.3. Tensor Analysis and Relativity	3	5
	2.5. **Elective-IV** (Choose any one) 2.5.1.Wavelets 2.5.2. Operations Research 2.5.3. Neural Networks	3	4
Part - B	2.6. **Skill Enhancement Course - I** Mathematical Documentation using LaTex.	2	3
	Total	**22**	**30**

Second Year

	Semester-III	**Credit**	**Hours per week**
Part - A	3.1. **CC-VII** : Complex Analysis	5	6
	3.2. **CC-VIII** : Probability Theory	5	6
	3.3. **CC-IX** : Topology	5	6
	3.4. **CC-X** :**Core Industry Module** Mechanics	4	6
	3.5. **Elective - V** (Choose any one) 3.5.1.Programming in C++ Theory 3.5.2. Mathematical Python Theory 3.5.3. Stochastic Process	3	3
Part - B	3.6. **Skill Enhancement Course - II** ProfessionalCommunication Skill :Term paper & Seminar presentation Assignment of Problem by 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 to 15 pages using LaTex) 25% Marks / Grade Points / Lecture Grade as per the Regulation)	2	3
	3.7. **Internship / Industrial Activity** (Carried out in Summer Vacation at the end of I year–30 hours) Summer Internship Report to be submitted to the Department.	2	
	Total	**26**	**30**

	Semester-IV	**Credit**	**Hours per week**
Part - A	4.1. **CC-XI** : Functional Analysis	5	6
	4.2. **CC-XII** : Differential Geometry	5	6
	4.3. Project with Viva Voce	7	10
	4.4. **Elective - VI** (Choose any one) 4.4.1. Programming in C++ Practical 4.4.2. Mathematical Python - Practical 4.4.3. Research Methodology	3	5
Part - B	4.5. **Skill Enhancement Course - III** Professional Competency Skill Enhancement Course Training for Competitive Examinations: Mathematics for NET / UGC - CSIR/ SET / TRB Competitive Examinations	2	3
Part - C	4.6. **Extension Activity** (Syllabus will be prepared by the University as common course to all PG Programmes)	1	
	Total	**23**	**30**
	TOTAL CREDITS		**91**

COMPONENT WISE CREDIT DISTRIBUTION

Credits	Sem I	Sem II	Sem III	Sem IV	Total
Core	14	14	19	10	57
Elective	6	6	3	3	18
Project				7	7
Soft Skill		2	2	2	6
Summer Internship / Industrial training			2		2
Extension activity				1	1
Total	**20**	**22**	**26**	**23**	**91**

Part - A component Core Courses (CC) and Part - B (i) will be taken into account for CGPA calculation for the Postgraduate programme and the other components Part - B and Part - C have to be completed during the duration of the programme as per the norms, to be eligible for obtaining the PG degree

CONSOLIDATED CREDITS DISTRIBUTION

Category of Courses	Credits for each Course	Number of Courses	Number of Credits in each Category	Total Credits	Total Credits for the Programme
Core		12	57	82	90 (CGPA)
Project with viva voce	7	1	7		
Elective	3	6	18		
Skill Enhancement Courses	2	3	6	6	
Summer Internship	1	2	2	2	
Extension Activity	1	1	1	1	1 (Non CGPA)
				TOTAL	**91**

TEMPLATE FOR SEMESTER

Semester	Category of Courses	Marks (Max 100)		Duration for UE	Credits
		CIA	UE		
I	1.1. Core - I	25	75	3 Hrs	5
	1.2. Core - II	25	75	3 Hrs	5
	1.3. Core - III	25	75	3 Hrs	4
	1.4. Elective - I	25	75	3 Hrs	3
	1.5. Elective - II	25	75	3 Hrs	3
II	2.1. Core - IV	25	75	3 Hrs	5
	2.2. Core - V	25	75	3 Hrs	5
	2.3. Core - VI	25	75	3 Hrs	4
	2.4. Elective - III	25	75	3 Hrs	3
	2.5. Elective - IV	25	75	3 Hrs	3
	2.6.Skill Enhancement course - I	Internal Assessment			2
III	3.1. Core - VII	25	75	3 Hrs	5
	3.2. Core - VIII	25	75	3 Hrs	5
	3.3. Core - IX	25	75	3 Hrs	5
	3.4. Core - X	25	75	3 Hrs	4
	3.5. Elective - V	25	75	3 Hrs	3
	3.6.Skill Enhancement course - II	Internal Assessment			2
	3.7.Internship/Industrial Activity				2
	4.1. Core - XI	25	75	3 Hrs	5
	4.2. Core - XII	25	75	3 Hrs	5
	4.3. Project with Viva-Voce	25	75	3 Hrs	7

IV	4.4. Elective - VI	25	75	3 Hrs	3
	4.5.Skill Enhancement course - III	Internal Assessment			2
	4.6.Extension Activity	Performance based assessment			1

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.

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 hours.

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 the Theory part and the other best from the two Laboratory parts. 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 hours. There is no improvement for CIA in both theory and laboratory, and also for University End Semester Examination.

In Elective - V, if 3.5.1 or 3.5.2 is chosen, then in Elective - VI, 4.4.1 or 4.4.2 is compulsory. (If a Computer Theory paper is chosen, then corresponding practical is compulsary).

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 2 mark**
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

SYLLABUS FOR DIFFERENT COURSES OF M.Sc. MATHEMATICS

SEMESTER – I

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">1.1 ALGEBRAIC STRUCTURES</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">CORE - I</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>I</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>4</td><td colspan="2">2</td><td colspan="2">-</td><td colspan="2">6</td></tr>
<tr><td colspan="2">Prerequisite</td><td colspan="8">UG level Modern Algebra</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="8">To introduce the concepts and to develop working knowledge on class equation, solvability of groups, finite abelian groups, linear transformations, real quadratic forms.</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="8">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)</td></tr>
<tr><td colspan="8">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</td></tr>
<tr><td colspan="8">UNIT-III : Linear Transformations: Canonical forms –Triangular form - Nilpotent transformations.
Chapter 6: Sections 6.4, 6.5</td></tr>
<tr><td colspan="8">UNIT-IV : Jordan form - rational canonical form.
Chapter 6 : Sections 6.6 and 6.7</td></tr>
<tr><td colspan="8">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)</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 Transferable Skill</td></tr>
<tr><td colspan="2">Recommended Text</td><td colspan="8">I.N. Herstein. Topics in Algebra (II Edition) Wiley Eastern Limited, New Delhi, 1975.</td></tr>
</table>

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

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

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">1.2 REAL ANALYSIS - I</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">CORE - II</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>I</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>4</td><td colspan="2">2</td><td colspan="2">-</td><td colspan="2">6</td></tr>
<tr><td colspan="2">Prerequisite</td><td colspan="8">UG level Real Analysis concepts</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="8">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="3">Course Outline</td><td colspan="8">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="8">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 - 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 7.6, 7.11- 7.14</td></tr>
<tr><td colspan="8">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.
Chapter - 7 : Sections 7.15 to 7.23</td></tr>
</table>

	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 : Sections 8.20, 8.21 to 8.26 **Power series** - Multiplication of power series - The Taylor's series generated by a function - Bernstein's theorem Chapter 9 : Sections 9.14 9.15, 9.19, 9.20
	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: Sections 9.1 to 9.6, 9.9, 9.10, 9.11.
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferable 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.

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

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">1.3 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>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>4</td><td colspan="2">2</td><td colspan="2">--</td><td colspan="2">6</td></tr>
<tr><td colspan="2">Prerequisite</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">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-Nonhomogeneous equation of order two.
Chapter 2: Sections 1 to 6</td></tr>
<tr><td colspan="2"></td><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="2"></td><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="2"></td><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="2"></td><td colspan="8">UNIT-V : Existence and uniqueness of solutions to first order equations: Equation with variable separation – 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>
<tr><td colspan="2">Skills acquired from this course</td><td colspan="8">Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferable Skill</td></tr>
<tr><td colspan="2">Recommended Text</td><td colspan="8">E.A.Coddington, A introduction to ordinary differential equations (3rd Printing) Prentice-Hall of India Ltd., New Delhi, 1987.</td></tr>
</table>

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 behaviour of solutions of systems of differential equations .

CLO2: Recognize the physical phenomena modelled 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.

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

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">1.4.1: GRAPH THEORY AND APPLICATIONS</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">ELECTIVE - I</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">3</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>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>4</td><td colspan="2">2</td><td colspan="2">--</td><td colspan="2">6</td></tr>
<tr><td colspan="2">Prerequisite</td><td colspan="8">Elementary Number Theory and basic Set Operations in Mathematics</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="8">To understand and apply the fundamental concepts in Graph Theory, to apply Graph Theory based tools in solving practical problems and to improve the proof writing skills.</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="8">UNIT-I : Basic Result: Subgraphs – Degrees of Vertices – Paths and Connectedness – Automorphism of a simple graph – Line graphs – Operations on graphs – Graph Products.
Chapter 1: Sec 1.1 to 1.9.</td></tr>
<tr><td colspan="8">UNIT-II :Connectivity: Vertex Cuts and Edge Cuts – Connectivity and Edge Connectivity – Blocks.
Chapter 3: Sec 3.1 to 3.4.</td></tr>
<tr><td colspan="8">UNIT-III : Trees: Definition, Characterization and simple properties - Centres and centroids - counting the numer of Spanning Trees -Cayley’s formula
Chapter 4: Sec 4.1 to 4.5.</td></tr>
<tr><td colspan="8">UNIT-IV : Independent Sets and Matchings: Vertex – Independent Sets and Vertex Coverings – Edge Independent Sets – Matchings and Factors – Matching in Bi-partite Graphs – Perfect Matching and the Tutte Matrix
Chapter 5: Sec 5.1 to 5.6.</td></tr>
<tr><td colspan="8">UNIT-V: Eulerian and Hamiltonian Graphs: Eulerian Graphs-Hamiltonian Graphs-Hamilton’s “Around the World” Game
Graph Colorings: Vertex colorings-Applications of Graph Colorings-Critical Graphs-Brooks’ Theorem.
Chapter 6: Sec 6.1 to 6.3,
Chapter 7: Sec 7.1 to 7.3 (up to Brooks theorem).</td></tr>
<tr><td colspan="2">Recommended Text</td><td colspan="8">R.Balakrishnan and K.Ranganathan, TextBook of Graph Theory, Springer Publications, 2012.</td></tr>
</table>

Reference Books	1. H.J.A Bondy and U.S.R.Murty. *Graph Theory with Applications*. North Holland, New York, Amsterdam, Oxford, 2008. 2. West, D. B., *Introduction to Graph Theory*, Pearson Education, 2011. 3. Robin J. Wilson, *Graph Theory*, Pearson Education, Asia 2002. 4. P. J. Cameron, J. H. van Lint, *Graph Theory, Coding Theory and Block Designs*, London Mathematical Society Lecture Note Series (19), Cambridge University Press, Reprint in April 2013. 5. Kenneth H. Rosen, *Discrete Mathematics and Its Applications*, McGraw Hill, 2007

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO 1: Demonstrate the concept of different structures and types about graphs and explain its applications.

CLO 2: Determine the properties of trees and applications in network and study the concepts of connections in graphs.

CLO 3: Acquire the knowledge about Euler Tours, Hamilton Cycles and matchings in Graphs.

CLO 4: Analyze the concept of edge colouring ,independent sets and cliques in Graphs

CLO 5: Explain the concept of vertex colorings.

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

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">1.4.2: FORMAL LANGUAGES AND AUTOMATA THEORY</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">ELECTIVE - I</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">3</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>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>4</td><td colspan="2">2</td><td colspan="2">--</td><td colspan="2">6</td></tr>
<tr><td colspan="2">Prerequisite</td><td colspan="8">Elementary Algebra</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="8">To know about Finite state Automata and systems, study about regular sets and its properties, grammar and normal form, languages and pushdown automata and Context free languages.</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="8">UNIT-I : Finite automata, regular expressions and regular grammars Finite state systems – Basic definitions – Nondeterministic finite automata – Finite automata with moves – Regular expressions – Regular grammars.
Chapter 2. Sections 2.1 to2.5 Chapter 9 Section 9.1</td></tr>
<tr><td colspan="8">UNIT-II : Properties of regular sets. The Pumping lemma for regular sets – Closure properties of regular sets – Decision algorithms for regular sets – The Myhill-Nerode Theorem and minimization of finite automata.
Chapter 3 : Sections 3.1 to 3.4</td></tr>
<tr><td colspan="8">UNIT-III : Context-free grammars Motivation and introduction – Context-free grammars – Derivation treesSimplification of context-free grammars – Chomsky normal form – Greibach normal form.
Chapter 4 : Section 4.1 to 4.6</td></tr>
<tr><td colspan="8">UNIT-IV : Pushdown automata Informal description-Definitions-Pushdown automata and context-free languages – Normal forms for deterministic pushdown automata. Chapter 5 : Sections 5.1 to 5.3</td></tr>
<tr><td colspan="8">UNIT-V: Properties of context-free languages The pumping lemma for CFL’s – Closure properties for CFL’s – Decision algorithms for CFL’s.
Chapter 6 : Sections 6.1 to 6.3</td></tr>
<tr><td colspan="2">Recommended Text</td><td colspan="8">John E.Hopcraft and Jeffrey D.Ullman, Introduction to Automata Theory, Languages and Computation, Narosa Publishing House, New Delhi, (1987).</td></tr>
</table>

Reference Books	1. A. Salomaa, *Formal Languages*, Academic Press, New York, (1973). 2. John C. Martin, *Introduction to Languages and theory of Computations* (2nd Edition) Tata-McGraw Hill Company Ltd., New Delhi, (1997).

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO1: Differentiate deterministic and nondeterministic finite automata.

CLO2: Acquire the knowledge of regular sets and its properties.

CLO3: Understand the concept of context free grammars and normal form.

CLO4: Define context free languages and pushdown automata.

CLO5: Explain about context free languages and pushdown automata.

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

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="7">1.4.3: ALGEBRAIC NUMBER THEORY</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="7">ELECTIVE - I</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">3</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>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td>4</td><td colspan="2">2</td><td colspan="2">--</td><td>6</td></tr>
<tr><td colspan="2">Prerequisite</td><td colspan="7">UG level Number Theory and Algebra Concept</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="7">To appreciate the significance of approximating irrational numbers, acquired the knowledge of Unique factorizations.</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="7">UNIT-I : Diophantine equations: Diophantine equations – The equation ax+by=c –Positive solutions – Other linear equations.</td></tr>
<tr><td colspan="7">UNIT-II : Some special equations: The equation $x^2 + y^2 = z^2$ -The equation $x^4 + y^4 = z^2$ –The equation $4x^2 + y^2 = n$</td></tr>
<tr><td colspan="7">UNIT-III : Infinite continued functions: The equations $ax^2 + by^2 + cz^2 = 0$ - Infinite continued functions – Irrational numbers.</td></tr>
<tr><td colspan="7">UNIT-IV : Quadratic Fields: Approximation to irrational numbers – Algebraic integers.</td></tr>
<tr><td colspan="7">UNIT-V: Unique Factorization – Units in quadratic fields.</td></tr>
<tr><td colspan="2">Recommended Text</td><td colspan="7">An introduction to the Theory of Numbers – Ivan Nivan and Herbert S. Zukerman – II edition, Wiley Eastern Ltd.
Chapter 5,6 and 9 (except 5.13, 5.14, 7.7,7.8 and 7.9)</td></tr>
<tr><td colspan="2">Reference Books</td><td colspan="7">Elements of Number Theory – Kumaravelu and Suseela Kumaravelu (2002), Raja Shankar Printers, Sivakasi (V edition)</td></tr>
</table>

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO 1: Demonstrate competence with the basic ideas of Diophantine and other linear equations
CLO 2: Solve some special equations of the type $x^4+y^4=z^2$
CLO 3: Able to demonstrate infinite continued functions.
CLO 4: Appreciate the significance of approximating irrational numbers.
CLO 5: Acquired the knowledge of Unique factorizations.

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

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">1.5.1: NUMBER THEORY AND CRYPTOGRAPHY</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">ELECTIVE - II</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">3</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>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>4</td><td colspan="2">2</td><td colspan="2">--</td><td colspan="2">6</td></tr>
<tr><td colspan="2">Prerequisite</td><td colspan="8">Mathematics of the UG level</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="8">The main objective of this course is to prepare students who either wish to pursue Mathematics as a career or need to use it from an application point of view. Cryptography and Cryptanalysis is a field where even non-mathematicians who are familiar with Elementary Number theory have flourished and this course will easily feed in their needs to familiarise them with rudiments of Cryptography.</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="8">UNIT-I : The fundamental Theorem of Arithmetic :Divisibility-greatest common divisor-fundamental theorem of Arithmetic-Euclidean Algorithm.</td></tr>
<tr><td colspan="8">UNIT-II : Congruences :Basic properties of congruences-residue classes and complete residue systems-linear congruences-polynomial congruences modulo p-Lagrange’s theorem and its applications-Chinese remainder theorem.</td></tr>
<tr><td colspan="8">UNIT-III : Arithmetical functions and Dirichlet Multiplication: Mobius function-Euler totient function- Dirichlet product of Arithmetic functions-Mangoldt functions-multiplicative functions-Liouville’s function-Bell series of an arithmetical function-derivatives of arithmetical functions</td></tr>
<tr><td colspan="8">UNIT-IV : CRYPTOGRAPHY
Cryptography – some simple cryptosystems – enciphering matrices.</td></tr>
<tr><td colspan="8">UNIT-V: PUBLIC KEY CRYPTOGRAPHY
Public key cryptography – idea of public key cryptography – RSA – discrete log –Knapsack cryptosystems.</td></tr>
<tr><td colspan="2">Recommended Text</td><td colspan="8">1. Neal Koblitz., (1987). Graduate Text in Mathematics A course in Number Theory and Cryptography, New York: Springer – Verlag, Print. (Chapter 3, 4: 4.1 to 4.4).
2. Tom.M.Apostol., (1998). Introduction to Analytic Number Theory, New Delhi: Narosa Publishing house, Eighth reprint. - Print. (Chapters 1 to 2, 5.1 to 5.7).</td></tr>
</table>

Reference Books	1. David M Burton, (2007). *Elementary Number Theory*, (6th ed.), New Delhi: Tata McGraw Hill Publishing House. Print. Wade Trappe, Lawrence C Washington., (2007). 2. *Introduction to Cryptography with coding theory*, (2nd ed.), New Delhi: Pearson Education. Print.
Website and e-Learning Source	1. https://youtu.be/lWV6tLpqJ3w 2. https://youtu.be/sr0LDJI98sY 3. https://youtu.be/eL9AmU5afR0. 4. https://youtu.be/5ltOfUUb-7U.

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO 1: Explain the concept of congruences and prove related results

CLO 2: Discuss the properties of different arithmetical functions

CLO 3: Derive Euler's summation formula and estimate the average order of different arithmetical functions

CLO 4: Explain simple cryptosystems and encipher matrices

CLO 5: Demonstrate public key cryptography

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

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">1.5.2: ANALYTIC NUMBER THEORY</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">ELECTIVE - II</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">3</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>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td>4</td><td colspan="2">2</td><td colspan="2">--</td><td>6</td></tr>
<tr><td colspan="2">Prerequisite</td><td colspan="6">Knowledge of differential and integral calculus of real functions in several variables, convergence of series, (uniform) convergence of sequences of functions, basics of complex analysis</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">To understand Dirichlet multiplication, a concept which helps clarify interrelationship between various arithmetical functions and also some equivalent forms of the prime number theorem.</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="6">UNIT-I : The Fundamental Theorem of Arithmetic.
Chapter 1 : Section 1.1 - 1.8
Exercise Problems:Chapter 1 : 1 - 11.</td></tr>
<tr><td colspan="6">UNIT-II :Arithmetic Functions.
Chapter 2: Sections 2.1 - 2.8.
Exercise problems:Chapter 2: 1 - 6.</td></tr>
<tr><td colspan="6">UNIT-III : Multiplicative Functions and Dirichlet Multiplication.
Chapter 2: Sections 2.9 – 2.14.
Exercise problems:Chapter 2: 21 - 23, 25, 26.</td></tr>
<tr><td colspan="6">UNIT-IV : Averages of Arithmetical Functions.
Chapter 3: Sections 3.1 - 3. 9.
Exercise problems:Chapter 3: 1 - 4.</td></tr>
<tr><td colspan="6">UNIT-V: Partial sums of Dirichlet Product, Chebyshev’s Functions – Equivalent forms of Prime Number Theorem.
Chapter 3: Sections: 3.10, 3.11, Chapter 4: Sections 4.1 – 4.4.
Exercise problems: Chapter 4: 3, 4, 5, 8.</td></tr>
<tr><td colspan="2">Recommended Text</td><td colspan="6">Introduction to Analytic Number Theory – Tom M. Apostol
-Springer,International Student Edition.</td></tr>
<tr><td colspan="2">Reference Books</td><td colspan="6">1. Problems in Analytic Number Theory, M. Ram Murty, Springer(2001)
2. Steps into Analytic Number Theory, Paul Pollack, Akash Singha Roy, Springer (2021)</td></tr>
</table>

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO 1: Study the basic concepts of elementary number theory

CLO 2: Explain several arithmetical functions and construct their relationships

CLO 3: Apply algebraic structure in arithmetical functions

CLO 4: Demonstrate various identities satisfied by arithmetical functions

CLO 5: Determine the application to $\mu(n)$ & $\lambda(n)$ and several equivalent form of prime number theorem

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

Title of the Course		**1.5.3: FUZZY SETS AND THEIR APPLICATIONS**					
Paper Number		ELECTIVE - II					
Category	Elective	Year	**I**	Credits	**3**	Course Code	
		Semester	**I**				
Instructional Hours per week		Lecture	Tutorial	Lab Practice	Total		
		4	2	--	**6**		
Prerequisite		Knowledge of graphs, relations, composition					
Objectives of the Course		To study about Fuzzy sets and their relations, Fuzzy graphs, Fuzzy relations, Fuzzy logic and laws of Fuzzy compositions					
Course Outline		**UNIT-I :** Fundamental Notions. Chapter I: Sec. 1 to 8					
		UNIT-II : Fuzzy Graphs. Chapter II: Sec. 10 to 18					
		UNIT-III : Fuzzy Relations. Chapter II: Sec. 19 to 29					
		UNIT-IV: Fuzzy Logic. Chapter III:Sec.31 to 40(omit Sec.37,38, 41)					
		UNIT-V: The Laws of Fuzzy Composition. Chapter IV: Sec.43 to 49					
Recommended Text		A.Kaufman, *Introduction to the theory of Fuzzy subsets*, Vol.I, Academic Press, New York, (1975).					
Reference Books		1. H.J.Zimmermann, *Fuzzy Set Theory and its Applications*, Allied Publishers, Chennai, (1996) 2. George J.Klir and Bo Yuan, *Fuzzy sets and Fuzzy Logic-Theory and Applications*, Prentice Hall India, New Delhi, (2001).					

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO1: Understand the definition of Fuzzy sets and its related concepts

CLO2: Define Fuzzy Graphs and can explain the concepts

CLO3: Explain the concepts in Fuzzy sets and its relations

CLO4: Discuss about Fuzzy logic

CLO5: Analyze the compositions of Fuzzy sets.

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

SEMESTER – II

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">2.1: ADVANCED ALGEBRA</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">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 colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td colspan="2">4</td><td colspan="2">2</td><td colspan="2">--</td><td>6</td></tr>
<tr><td colspan="2">Prerequisite</td><td colspan="8">Algebraic Structures</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="8">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="8">UNIT-I : Extension fields – Transcendence of e.
Chapter 5: Section 5.1 and 5.2</td></tr>
<tr><td colspan="8">UNIT-II : Roots of Polynomials.- More about roots
Chapter 5: Sections 5.3 and 5.5</td></tr>
<tr><td colspan="8">UNIT-III : Elements of Galois theory.
Chapter 5 : Section 5.6</td></tr>
<tr><td colspan="8">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="8">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>
<tr><td colspan="2">Skills acquired from this course</td><td colspan="8">Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferable Skill</td></tr>
<tr><td colspan="2">Recommended Text</td><td colspan="8">I.N. Herstein. Topics in Algebra (II Edition) Wiley EasternLimited, New Delhi, 1975.</td></tr>
<tr><td colspan="2">Reference Books</td><td colspan="8">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.</td></tr>
</table>

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.

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

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">2.2: 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>Lecture</td><td>Tutorial</td><td colspan="2">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>4</td><td>2</td><td colspan="2">--</td><td colspan="2">6</td></tr>
<tr><td colspan="2">Prerequisite</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="4">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>
<tr><td colspan="6">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 Theorem - 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 –Cesaro Summability of Fourier series- Consequences of Fejes's theorem - The Weierstrass approximation theorem
Chapter 11 : Sections 11.1 to 11.15 (Apostol)</td></tr>
<tr><td colspan="6">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)</td></tr>
</table>

	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 several variables-Extremum problems with side conditions. Chapter 13 : Sections 13.1 to 13.7 (Apostol)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferable 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. Royden,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 the 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.

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

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">2.3: PARTIAL DIFFERENTIAL EQUATIONS</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">CORE - VI</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>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>4</td><td colspan="2">2</td><td colspan="2">--</td><td colspan="2">6</td></tr>
<tr><td colspan="2">Prerequisite</td><td colspan="8">UG level Partial Differential Equations</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="8">To classify the second order partial differential equations and to study Cauchy problem, method of separation of variables, boundary value problems.</td></tr>
<tr><td colspan="2">Course Outline</td><td colspan="8">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)</td></tr>
<tr><td colspan="2"></td><td colspan="8">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</td></tr>
<tr><td colspan="2"></td><td colspan="8">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)</td></tr>
<tr><td colspan="2"></td><td colspan="8">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</td></tr>
</table>

	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
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferable Skill
Recommended Text	TynMyint-U and Lokenath Debnath, *Partial Differential Equations for Scientists and Engineers* (Third Edition), North Holland, 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 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

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

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">2.4.1: ALGEBRAIC TOPOLOGY</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">ELECTIVE -III</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">3</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>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>4</td><td colspan="2">1</td><td colspan="2">--</td><td colspan="2">5</td></tr>
<tr><td colspan="2">Prerequisite</td><td colspan="8">UG level Real Analysis, Algebraic Structures and some fundamental knowledge of topology.</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="8">To introduce the ideas of Algebraic Topology to other branches of Mathematics</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="8">UNIT-I : Homotopy of paths, fundamental group of a topological space, homotopy of maps of topological spaces, contractible and simply connected spaces.
Chapter 9: Sec: 51, 52.</td></tr>
<tr><td colspan="8">UNIT-II :The Fundamental group of the circle, Path lifting lemma, Retractions and fixed points, Brouwer's fixed- point theorem for the disc, The fundamental Theorem of Algebra.
Chapter 9. Sec: 54, 55, 56</td></tr>
<tr><td colspan="8">UNIT-III : Covering spaces, Equivalence of covering spaces, The general lifting lemma, The universal covering space.
Chapter 9 : Sec: 53, Chapter 13: Sec: 79, 80</td></tr>
<tr><td colspan="8">UNIT-IV : Separation theorems in the plane, Null homotopy lemma, The Jordan separation theorem, A general separation theorem, Homotopy Extension lemma, Borsuk lemma, Invariance of domain.
Chapter 10: Sec: 61, 62</td></tr>
<tr><td colspan="8">UNIT-V: Applications to Group theory: Covering spaces of a graph, The fundamental group of a graph.
Chapter 14: Sec 83, 84.</td></tr>
<tr><td colspan="2">Recommended Text</td><td colspan="8">James R. Munkres, Topology, Prentice Hall of India, New Delhi, 2002 (2nd Edition).</td></tr>
<tr><td colspan="2">Reference Books</td><td colspan="8">1. M.K.Agoston, Algebraic topology- A First Course, Marcel Dekker, 1962
2. Satya Deo, Algebraic Topology, Hindustan Book Agency, New Delhi, 2003.
3. M.Greenberg and Harper, Algebraic Topology-A First course, Benjamin/Cummings, 1981.
4. C.F. Maunder, Algebraic topology, Van Nastrand, New York, 1970</td></tr>
</table>

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO 1: Give an account of the concepts homotopy, homology and cohomology, their basic properties and relationships

CLO 2: Prove topological results by using algebraic methods

CLO 3: Use the theory to solve elementary topological problems

CLO 4: Compute algebro-topological invariants in specific examples

CLO 5: Explain the fundamental concepts of algebraic topology and their role in modern mathematics and applied contexts.

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

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">2.4.2: MATHEMATICAL STATISTICS</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">ELECTIVE - III</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">3</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>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>4</td><td colspan="2">1</td><td colspan="2">--</td><td colspan="2">5</td></tr>
<tr><td colspan="2">Prerequisite</td><td colspan="8">UG level Combinatorics and basic set theory</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="8">To understand mathematical statistics, acquire basic knowledge about various distributions, understand mathematical expectations, marginal and conditional distributions, the gamma and chi-square distributions, the t & F distributions and their applications, moment generating function technique and the Central Limit Theorem.</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="8">UNIT-I : The probability set function – Random Variables – Probability density function – Distribution function – Mathematical expectation – Special mathematical expectations – Chebyshev’s Inequality.</td></tr>
<tr><td colspan="8">UNIT-II : Conditional probability – Marginal and conditional distributions – Stochastic independence Some special distributions: The Binomial, Trinomial and Multinomial distributions – The Poisson distribution</td></tr>
<tr><td colspan="8">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 discrete type – Transformations of variables of the continuous type.</td></tr>
<tr><td colspan="8">UNIT-IV : The β, t and F distributions – Distributions of order statistics – The moment generating function technique. The distributions of χ^2 and nS^2/σ^2 – Expectations of functions of random variables.</td></tr>
<tr><td colspan="8">UNIT-V: Limiting distributions -Stochastic convergence – Limiting moment generating functions – The central limit theorem – Some theorems on limiting distributions.</td></tr>
<tr><td colspan="2">Recommended Text</td><td colspan="8">Robert V. Hogg and Allen T. Craig, Introduction to Mathematical Statistics (fourth edition) Chapter 1,2 (except 1.1,1.2,1.3,1.8 & 2.3), Chapter 3,4 (except 4.5) and Chapter 5.</td></tr>
</table>

Reference Books	1. M. Fisz, Probability theory and Mathematical Statistics, John Wiley & sons, New York, 1963. 2. E.J. Dudewiczn and S.N. Mishra, Modern Mathematical Statistics, John Wiley & sons, New York, 1988. 3. V.N. Rohatgi, An introduction to Probability theory and Mathematical statistics, Wiley Eastern Limited, New Delhi, 1988

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO 1: Discuss the sets, functions of sets,randing variables and certain expectations
CLO 2: Discuss binomial and related distributions
CLO 3: To study various kinds of distributions
CLO 4: Discuss additional distributions and order statistics and statistical applications
CLO 5: To learn the convergence in distribution of a sequence of random variables

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

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">2.4.3: TENSOR ANALYSIS AND RELATIVITY</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">ELECTIVE - III</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">3</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>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>4</td><td colspan="2">1</td><td colspan="2">--</td><td colspan="2">5</td></tr>
<tr><td colspan="2">Prerequisite</td><td colspan="8">UG level Vector Calculus and Mechanics.</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="8">To get the knowledge of Tensor of different orders and tensor calculus in Riemann spaces.
To know about the relativity of transformation, kinematics and Doppler effect and to
understand about energy, mass and inelastic collision.</td></tr>
<tr><td colspan="2" rowspan="4">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 – 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="8">UNIT-II : Tensor Calculus : Riemannian Space – Christoffel Symbols and their properties.
Chapter III: III.1 and III.2</td></tr>
<tr><td colspan="8">UNIT-III : Tensor Calculus(contd) : Covariant Differentiation of Tensors – Riemann–Christoffel Curvature Tensor – Intrinsic Differentiation
Chapter III:III.3 – III.5</td></tr>
<tr><td colspan="8">UNIT-IV : Special Theory of Relativity : Galilean Transformations – 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>
</table>

	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
Recommended Text	1. U.C. De, Absos Ali Shaikh and Joydeep Sengupta, *Tensor Calculus*, Narosa Publishing House, New Delhi, 2004. (Units I,II and III) 2. D.Greenwood, *Classical Dynamics*, Prentice Hall of India, New Delhi, 1985(Units IV and V)
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*, Newyor, 1942. 4. C.E.Weatherburn, *Riemannian Geometry and the Tensor Calculus*, Cambridge, 1938.

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO1: Understand the system of different orders in Tenor Algebra.

CLO2: Explain about Tensor Calculus in Riemann spaces.

CLO3: Understand the concept of Covariant of differentiation and intrinsic differentiation

CLO4: Explain about the theory of relativity and Doppler effect.

CLO5: Analyze about the conservation of mass and energy.

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

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">2.5.1: WAVELETS</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">ELECTIVE - IV</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">3</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>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td>3</td><td colspan="2">1</td><td colspan="2">--</td><td>4</td></tr>
<tr><td colspan="2">Prerequisite</td><td colspan="6">Basic Analysis and Linear Algebra</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">To know about wavelet transformation and Fourier transformations, Wavelet series and Fourier series, Cardinal spline spaces and its properties, functions and wavelets and Cardinal spline wavelets.</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="6">UNIT-I : An Overview : Fourier to Wavelets – Integral Wavelets Transform and Time frequency analysis – Inversion formulas and duals – Classification of Wavelets – Multiresolution analysis – Spines and Wavelets. Fourier Analysis : Fourier and Inverse Fourier Transformation – Continuous Time Convolution – The delta function – Fourier Transformation of square integrable functions.</td></tr>
<tr><td colspan="6">UNIT-II : Fourier Analysis (contd): Fourier Series – Basic Convergence Theory – Poisson Summation Formula. Wavelet Transforms and Time Frequency Analysis : The Gabor Transforms – Short time Fourier Transforms and the uncertainty principle – The integral Wavelet Transform – Dyadic Wavelets – Inversion – Frames – Wavelet Series.</td></tr>
<tr><td colspan="6">UNIT-III : Cardinal Spline Analysis : Cardinal Spline spaces – B-splines and their basic properties – The time scale relation and an interpolating graphical display algorithm – B-Net representations and computation of cardinal splines – Constructions of cardinal splines – constructions of spline application formulas – Construction of Spline interpolation formulas</td></tr>
<tr><td colspan="6">UNIT-IV : functions and Wavelets : Multi-resolution analysis – Scaling functions with finite two scale relation – Direction sum Decompositions of L 2 (R) - Wavelets and their duals</td></tr>
<tr><td colspan="6">UNIT-V: Cardinal Splines Wavelets : Interpolating splines wavelets – Compactly supported spline – Wavelets – Computation of Cardinal spline Wavelets – Euler – Frebenious Polynomials(12 hours). Orthogonal Wavelets : Examples of orthogonal Wavelets – Identification of orthogonal two scale symbols – Construction of compactly supported orthogonal wavelets.</td></tr>
<tr><td colspan="2">Recommended Text</td><td colspan="6">Content and Treatment as in Charles K. Chui, An introduction to Wavelets, Academic Press, New York, 1992.</td></tr>
</table>

Reference Books	1. Chui C. K. (ed) *Approximation theory and Fourier Analysis*, Academic Press Boston, 1991. 2. Daribechies. I, Wavelets, CBMS-NSF Series in Appl, SIAM Philadelphia, 1992. 3. Schurnaker, L. L., *Spline Functions : Basic Theory*, Wiley, New York, 1981. 4. Nurnberger, G, *Applications to Spline Functions*, Springer Verlag, New York, 1989.

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO1: Determine integral wavelet transform, Fourier and inverse Fourier Transformation

CLO2: Explain the concepts of Fourier and Wavelet series and their properties

CLO3: Understand about the spline and interpolation formula

CLO4: Analyze about the multi resolution analysis

CLO5: Determine about computation of cardinal spline Wavelets

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

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">2.5.2: OPERATIONS RESEARCH</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">ELECTIVE - IV</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">3</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>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">Prerequisite</td><td colspan="8">Knowledge of probability distributions and statistics</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="8">To analyse different situations in the industrial/ business scenario involving limited resources and finding the optimal solution within constraints.</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="8">UNIT-I : Transportation Models and its Variants: Definition of the Transportation Model – Non-Traditional Transportation Model– Transportation Algorithm – The Assignment Model.
Chapter 5: Sections 5.1, 5.2, 5.3, 5.4. Exercise problems.</td></tr>
<tr><td colspan="8">UNIT-II :Network Analysis: Network Definitions – Minimal Spanning Tree Algorithm –Shortest Route Problem – Maximum Flow Model – CPM –PERT.
Chapter 6: Sections 6.2, 6.3, 6.4, 6.5, 6.7. Exercise problems.</td></tr>
<tr><td colspan="8">UNIT-III : Integer Linear Programming: Introduction – Applications –Integer Programming Solutions – Algorithms.
Chapter 9: Sections 9.1, 9.2, 9.3. Exercise problems.</td></tr>
<tr><td colspan="8">UNIT-IV : Inventory Theory: Basic Elements of an Inventory Model –Deterministic Models: Single Item Stock Model With And Without Price Breaks –Multiple Items Stock Model With Storage Limitations – Probabilistic Models:Continuous Review Model-Single Period Models.
Chapter 11 – Sections 11.1, 11.2, 11.3, Chapter 16 –Sections 16.1, 16.2, 16.3, Exercise problems.</td></tr>
<tr><td colspan="8">UNIT-V: Queuing Theory: Basic Elements of Queuing Model – Role of Poisson and Exponential Distributions – Pure Birth and Death Models –Specialised Poisson Queues - (M/G/1): GD/∞/∞)-Pollaczek - Khintechine Formula.
Chapter 17: Sections 17.2, 17.3, 17.4, 17.6, 17.7. Exercise problems.</td></tr>
<tr><td colspan="2">Recommended Text</td><td colspan="8">Operations Research (Sixth Edition), Hamdy A. Taha, Prentice Hall of India Private Limited, New Delhi.</td></tr>
<tr><td colspan="2">Reference Books</td><td colspan="8">1. Operations Research, H.K Pathak, Dr. Pradeep K. Joshi and C.Sharma,Shree Shiksha Sahitya Prakashan Publication, Reprint 2022-23.
2. Operations Research: Principles and Applications, Second Edition, G. Srinivasan, Easrern Economy Edition, PHI</td></tr>
</table>

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO 1: Be able to build and solve Transportation and Assignment problems using appropriate method

CLO 2: Learn the constructions of network and optimal scheduling using CPM and PERT

CLO 3: Ability to construct linear integer programming models and solve linear integer programming models using branch and bound method

CLO 4: Understand the need of inventory management.

CLO 5: To understand basic characteristic features of a queuing system and acquire skills in analyzing queuing models

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

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">2.5.3: NEURAL NETWORKS</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">ELECTIVE - IV</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">3</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>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">Prerequisite</td><td colspan="8">Familiarity with linear algebra, multivariate calculus and probability theory</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="8">To know the main fundamental principles and techniques of neural network systems and investigate the principal neural network models and applications. Acquire in-depth knowledge in Nonlinear dynamics. Apply neural networks to classification and generalization problems.</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="8">UNIT-I :Neuron Model and Network Architectures:Mathematical Neural Model-Network Architectures-Perceptron-Hamming Network-Hopfield Network-Learning Rules.</td></tr>
<tr><td colspan="8">UNIT-II :Perceptron Architectures: Perceptron Architectures and Learning Rules with proof of convergence-Supervised Hebbian Learning-Linear Associator.</td></tr>
<tr><td colspan="8">UNIT-III : Supervised Hebbian Learning: The Hebb Rule-Pseudo inverse rule-Variation of Hebbian Learning-Back Propagation-Multilayer Perceptrons.</td></tr>
<tr><td colspan="8">UNIT-IV: Back Propagation: Back Propagation algorithm-convergence and Generalization-Performances surfaces and optimum points-Taylor series.</td></tr>
<tr><td colspan="8">UNIT-V: Performance surface and performance optimizations: Directional derivatives-Minima-Necessary conditions for optimality-Quadratic functions-Performance optimizations-Steepest Descent Newton’s method-Conjugate Gradient.</td></tr>
<tr><td colspan="2">Recommended Text</td><td colspan="8">Martin T. Hagan, Howard B/Demuth and Mark Beale, Neural Network Design, Vikas Publishing House, New Delhi, 2002.</td></tr>
<tr><td colspan="2">Reference Books</td><td colspan="8">1. James A.Freeman, David M.Skapura, Neural Networks Algorithms, Applications and Programming Techniques, Pearson Education, 2003.
2. Robert J. Schalkoff, Artificial Neural Network, McGraw-Hill International Edition, 1997.</td></tr>
<tr><td colspan="2">Website and e-Learning Source</td><td colspan="8">1. https://nptel.ac.in/courses/117/105/117105084/
2. https://nptel.ac.in/courses/106/106/106106184/</td></tr>
</table>

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO 1: Understand and analyze different neutron network models

CLO 2: Understand the basic ideas behind most common learning algorithms for multilayer perceptions, radial basis function networks.

CLO 3: Describe Hebb rule and analyze back propagation algorithms with examples.

CLO 4: Study convergence and generalization and implement common learning algorithms.

CLO 5: Study directional derivatives and necessary conditions for optimality and to evaluate quadratic functions.

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

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">2.6: MATHEMATICAL DOCUMENTATION USING LaTex</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">Skill Enhancement Course - I</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">SEC</td><td>Year</td><td>I</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</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>1</td><td colspan="2">-</td><td colspan="2">2</td><td colspan="2">3</td></tr>
<tr><td colspan="2">Prerequisite</td><td colspan="8">Basic knowledge in computer</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="8">To type Mathematical documents in a simple way.</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="8">UNIT-I : Introduction - Basics of a Latex file- Text, Symbols and Commands: Command names and arguments – Environments– Declarations – Lengths – Special characters</td></tr>
<tr><td colspan="8">UNIT-II : Document Layout and Organization: Document class – Page style – Parts of the document – Table of contents</td></tr>
<tr><td colspan="8">UNIT-III : Displayed Text: Changing font style – Centering and indenting – Lists – Generalized lists Theorem like-declarations</td></tr>
<tr><td colspan="8">UNIT-IV : Text in Boxes: Boxes - Footnotes and marginal notes. Tables: Tabular stops – Tables</td></tr>
<tr><td colspan="8">UNIT-V: Mathematical Formulas: Mathematical Environment – Main elements of math mode – Mathematical symbols - Additional Elements.</td></tr>
<tr><td colspan="2">Recommended Text</td><td colspan="8">Guide to LaTeX, Helmut Kopka and Patrick W.Daly, Fourth Edition, Addison – Wesley, Pearson Education, 2004.</td></tr>
<tr><td colspan="2">Reference Books</td><td colspan="8">1. E. Krishnan, LaTeX TUTORIALS — A Primer, Indian TEX Users Group, 2003
2. H. Kopka and P.W. Daly, A Guide to LaTeX, Addison - Wesley, 2003.
3. Martin J. Erickson and Donald Bindner, A Student's Guide to the Study, Practice, and Tools of Modern Mathematics, CRC Press, Boca Raton, FL, 2011</td></tr>
</table>

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO 1: To learn the latest techniques in Latex for the preparation of printable documents in an enhanced manner.

CLO 2: To avoid difficulty while typing a project or thesis comparing other mathematical software.

CLO 3: To write mathematical equations and to draw graphs using Latex

CLO 4: To fix footnotes and header

CLO 5: To create tables and type formulae in Mathematics

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

SEMESTER – III

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">3.1: COMPLEX ANALYSIS</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">CORE - VII</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" 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">4</td><td colspan="2">2</td><td colspan="2">--</td><td>6</td></tr>
<tr><td colspan="2">Prerequisite</td><td colspan="8">UG level Complex Analysis</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="8">To Study Cauchy integral formula, local properties of analytic functions, general form of Cauchy’s theorem and evaluation of definite integral and harmonic functions.</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="8">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 analytic Functions:Removable Singularities-Taylor'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</td></tr>
<tr><td colspan="8">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</td></tr>
<tr><td colspan="8">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</td></tr>
<tr><td colspan="8">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</td></tr>
<tr><td colspan="8">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</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 Transferable Skill</td></tr>
</table>

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, Narosa Publishing Co.1978 3. E. Hille, *Analytic function Theory* (2 vols.), Gon & 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 .

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

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">3.2: PROBABILITY THEORY</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">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" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="2">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>4</td><td>2</td><td colspan="2">--</td><td colspan="2">6</td></tr>
<tr><td colspan="2">Prerequisite</td><td colspan="6">UG level Algebra, Calculus and knowledge on Mathematical Statistics.</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">To introduce an 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" rowspan="4">Course Outline</td><td colspan="6">UNIT-I : Random Events and Random Variables: Random events – Probability axioms – Combinatorial formula – 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="6">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="6">UNIT-III: Characteristic functions : Properties of characteristic functions – Characteristic functions and moments – semi invariants – 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="6">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>
</table>

	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's Weak law of large numbers – Lindberg Theorem – Lyapunov Theorem – 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)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferable 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. 3. R.Durrett, *Probability : Theory and Examples*, (2nd Edition) Duxbury Press, New York, 1996. 4. V.K.Rohatgi*An Introduction to Probability Theory and Mathematical Statistics*, Wiley Eastern Ltd., New Delhi, 1988(3rd Print). 5. S.I.Resnick, *A Probability Path*, Birhauser, Berlin,1999. 6. 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.

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

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">3.3: TOPOLOGY</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">CORE - IX</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" 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>4</td><td colspan="2">2</td><td colspan="2">--</td><td colspan="2">6</td></tr>
<tr><td colspan="2">Prerequisite</td><td colspan="8">UG level Real Analysis</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="8">To study topological spaces, continuous functions, connectedness, compactness, countability and separation axioms.</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="8">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</td></tr>
<tr><td colspan="8">UNIT-II :Continuous functions: Continuous functions – the product topology – The metric topology.
Chapter 2 : Sections 18 to 21 (Omit Section 22)</td></tr>
<tr><td colspan="8">UNIT-III :Connectedness: Connected spaces- connected subspaces of the Real line – Components and local connectedness.
Chapter 3 : Sections 23 to 25.</td></tr>
<tr><td colspan="8">UNIT-IV : Compactness : Compact spaces – compact subspaces of the Real line – Limit Point Compactness – Local Compactness.
Chapter 3 : Sections 26 to 29.</td></tr>
<tr><td colspan="8">UNIT-V: Countability and Separation Axiom: The Countability Axioms – The separation Axioms – Normal spaces – The Urysohn Lemma – The Urysohn Metrization Theorem – The Tietz extension theorem.
Chapter 4 : Sections 30 to 35.</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 Transferable Skill</td></tr>
<tr><td colspan="2">Recommended Text</td><td colspan="8">James R. Munkres, Topology (2nd Edition) Pearson Education Pve. Ltd., Delhi-2002 (Third Indian Reprint)</td></tr>
<tr><td colspan="2">Reference Books</td><td colspan="8">1. H.K Pathak and J.P Chauhan, Topology, Shree Shiksha Sahitya Prakashan Publisher, Reprint 2023-2024.
2. J. Dugundji ,Topology , Prentice Hall of India, New Delhi, 1975.
3. George F.Sinmons, Introduction to Topology and Modern Analysis, McGraw Hill Book Co., 1963
4. J.L. Kelly, General Topology, Van Nostrand, Reinhold Co., New York
5. L.Steen and J.Subhash, Counter Examples in Topology, Holt, Rinehart and Winston, New York, 1970.
6. S.Willard, General Topology, Addison - Wesley, Mass., 1970</td></tr>
</table>

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).

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

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">3.4: MECHANICS</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">CORE - X</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">4</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>III</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>Total</td></tr>
<tr><td>4</td><td colspan="2">2</td><td colspan="2">--</td><td>6</td></tr>
<tr><td colspan="2">Prerequisite</td><td colspan="6">UG level Calculus and Differential equations.</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">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.</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="6">UNIT-I : Mechanical Systems : The Mechanical system- Generalised coordinates – Constraints - Virtual work - Energy and Momentum
Chapter 1 : Sections 1.1 to 1.5</td></tr>
<tr><td colspan="6">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)</td></tr>
<tr><td colspan="6">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)</td></tr>
<tr><td colspan="6">UNIT – IV : Hamilton-Jacobi Theory : Hamilton Principle function – Hamilton-Jacobi Equation - Separability
Chapter 5 : Sections 5.1 to 5.3</td></tr>
<tr><td colspan="6">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)</td></tr>
<tr><td colspan="2">Skills acquired from this course</td><td colspan="6">Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferable Skill</td></tr>
<tr><td colspan="2">Recommended Text</td><td colspan="6">D. Greenwood, Classical Dynamics, Prentice Hall of India, New Delhi, 1985.</td></tr>
<tr><td colspan="2">Reference Books</td><td colspan="6">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 (3rdEdition) McGraw Hill Book Co., New York, 1970.</td></tr>
<tr><td colspan="2">Website and e-Learning Source</td><td colspan="6">http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics, http://www.opensource.org, www.physicsforum.com</td></tr>
</table>

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

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

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">3.5.1: PROGRAMMING IN C++</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">ELECTIVE - V</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>III</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>2</td><td colspan="2">1</td><td colspan="2"></td><td colspan="2">3</td></tr>
<tr><td colspan="2">Prerequisite</td><td colspan="8">Basic functionality of computer programs.</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="8">To learn the syntax of the C++ programming language, to learn how to design C++ classes for code reuse, how to implement copy constructors and class member functions, to understand the concept of data abstraction and encapsulation and to learn how to overload functions and operators in C++.</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="8">UNIT-I : Structure of C++ program – Tokens – Keywords –Identifiers and constants- all data types – Constants – all variables – All operators- Manipulator.
Chapter 2 : Sec : 2.6
Chapter 3 : Sec : 3.1 – 3.18</td></tr>
<tr><td colspan="8">UNIT-II : All Expressions – Conversion – Operator overloading – Operator Precedence – Control Structures- Functions in C++ - Introduction – Main Function – Function Prototyping- Return by reference
Chapter 3, Sec: 3.19 -3.24
Chapter 4, Sec : 4.1 – 4.5</td></tr>
<tr><td colspan="8">UNIT-III : Inline Functions – arguments – Function overloading – all functions classes and Objects.
Chapter 4 , Sec: 4.6 -4.11
Chapter 5, Sec: 5.1 – 5.5</td></tr>
<tr><td colspan="8">UNIT-IV :Nesting of member functions – Private member function – Arrays with in a class and Objects – Friendly function – Returning Objects – Pointers to members – Local Classes
Chapter 5, Sec 5.7 – 5.19</td></tr>
<tr><td colspan="8">UNIT-V :Constructors and Destructors – Operator overloading and Type conversions.
Chapter 6 & 7.</td></tr>
<tr><td colspan="2">Skills acquired from this course</td><td colspan="8">Will gain the knowledge of programming with C++ and able to find the numerical solutions of the linear equations</td></tr>
<tr><td colspan="2">Recommended Text</td><td colspan="8">1. E. Balagurusamy, Object Oriented Programming with C++, Tata McGraw Hill, New Delhi, (1999).
2. V.Ravichandran, Programming with C++, Second Edition Tata McGraw- Hill, New Delhi, 2006.</td></tr>
</table>

Reference Books	1. D. Ravichandran, *Programming with C++*, Tata McGraw Hill, New Delhi, (1996) 2. Conte and de Boor, *Numerical Analysis*, McGraw Hill, New York, (1990) 3. John H.Mathews, *Numerical Methods for Mathematics*, Science and Engineering (2nd Edn.), Prentice Hall, New Delhi, (2000) 4. Devi Prasad, *An Introduction to Numerical Analysis* (3rd edn) Narosa Publishing House, New Delhi, (2006).
Website and e-Learning Source	1. https://youtu.be/LbKKzMag5Rc 2. https://youtu.be/Xb9Ypn77LBo 3. https://youtu.be/FfqAIlOxkoY

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO 1: Understanding about object oriented programming. Learn how to store one object inside another object

CLO 2: Gain knowledge about the capability to store information together in an object.

CLO 3: Understand the capability of a class to rely upon another class. Learn use of one method can be used in variety of different ways

CLO 4: Understanding the process of exposing the essential data to the outside of the world and hiding the low level data .Create and process data in files using file I/O functions

CLO 5: Understand about constructors which are special type of functions. Discuss to know about writing style

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

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">3.5.2: MATHEMATICAL PYTHON - THEORY</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">ELECTIVE -V</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>III</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>2</td><td colspan="2">1</td><td colspan="2">--</td><td colspan="2">3</td></tr>
<tr><td colspan="2">Prerequisite</td><td colspan="8">Basic computer skills, mathematical problem solving</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="8">To demonstrate Problem Solving Techniques, Algorithmic Problem Solving , Understanding of basic Python and Python functions in mathematical problem solving</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="8">UNIT-I : PROBLEM SOLVING TECHNIQUES: Problem solving Techniques – Algorithm, flowchart, pseudocode, programming; Algorithms: properties, quality (time, space); building blocks of algorithms - statements, state, control flow, functions, notation (pseudo code, flow chart, programming language)</td></tr>
<tr><td colspan="8">UNIT-II :ALGORITHMIC PROBLEM SOLVING: Algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion), pseudocode for some Mathematical Problems – greatest of two numbers, print n natural numbers, greatest common divisor, fibonacci sequence upto n terms. Practical applications of algorithms.</td></tr>
<tr><td colspan="8">UNIT-III : INTRODUCTION TO PYTHON: Introduction to Python, Python interpreter, Modes of Python Interpreter, Values and Data Types, Variables, Keywords, Identifiers, Statements and Expressions, Input and Output, Comments, Docstring, Lines and Indentation, Quotation, Tuple Assignment, Operators and Types of Operators, Operator Precedence.</td></tr>
<tr><td colspan="8">UNIT-IV : PYTHON FUNCTIONS: Functions, Types of function, Function definition (Sub program), Flow of Execution, Function Prototypes, Parameters and Arguments; Modules; Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion.</td></tr>
<tr><td colspan="8">UNIT-V: STRING, LISTS, TUPLES IN PYTHON:Strings: string slices, immutability, string functions and methods, string module; Lists as arrays. Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value.</td></tr>
<tr><td colspan="2">Recommended Text</td><td colspan="8">Allen B. Dowley, Think Python: How to Think Like a Computer Scientist, 2nd Edition.</td></tr>
</table>

Reference Books	1. Wes McKinney, *Python for Data Analysis: Data Wrangling with Pandas, NumPy, and Ipython*, O'Reilly, 2nd Edition, 2018. 2. Jake VanderPlas, *Python Data Science Hand Book: Essential Tools for working with Data*, O'Reilly, 2017. 3. Wesley J. Chun, *Core Python Programming*, Prentice Hall, 2006. 4. N.Safina Devi and C.Devamanoharan, *Algorithmic Problem Solving and Python- A Beginner's Guide*, Francidev Publications, 2023.
Website and e-Learning Source	1. ttp://www.programmer-books.com/introducing-data-science-pdf/ 2. http://www.CS.uky.edu/~keen/115/haltermanpythonbook.pdf 3. http://math.ecnu.edu.cn/~lfzhou/seminar/IJoel Geusl Datascience from Scratch First Princ.pdf

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO 1: Give mathematical model for real world problems

CLO 2: Design algorithms for mathematical models, analyse the efficiency and correctness of algorithms.

CLO 3: Design implementable programs in Python.

CLO 4: Define and demonstrate the use of functions and looping using Python.

CLO 5: Design and implement a program to solve a real-world problem.

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

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">3.5.3: STOCHASTIC PROCESS</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">ELECTIVE -V</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>III</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>Total</td></tr>
<tr><td>2</td><td colspan="2">1</td><td colspan="2">--</td><td>3</td></tr>
<tr><td colspan="2">Prerequisite</td><td colspan="6">Probability Theory</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">To get an idea of different types of processes and to know about the Markov chains. Also to know about the Brownian Motion and Renewal processes.</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="6">UNIT-I : Markov Chains : Classification of general stochastic processes – markov chain – Examples – Transition probability matrix – Classification of states - Recurrence
Chapter 1 : Section 3 only and Chapter 2 : sections 1 to 5.</td></tr>
<tr><td colspan="6">UNIT-II : Limit theorems of Markov chains : Discrete renewal equation and its proof – Absorption probabilities – criteria for recurrence – Queuing models
Chapter 3 : Sections 1 to 7</td></tr>
<tr><td colspan="6">UNIT-III : Continuous time Markov Chains : Poisson process – Pure Birth process – Birth and Death process - Birth and Death process with absorbing states
Chapter 1 : Section 2 (Poisson process) Chapter 4 : Sections 1, 2 and 4to 7 (omit sections 3 and 8)</td></tr>
<tr><td colspan="6">UNIT-IV : Renewal processes : Definition and related concepts – Some special renewal processes
Chapter 5 : sections 1 - 3</td></tr>
<tr><td colspan="6">UNIT-V: Brownian Motion : Definition – Joint probabilities for Brownian Motion – Continuity of paths and the maximum variables – Variations and extensions
Chapter 1 : Section 2 (Brownian Motion) Chapter 6 : sections 1 to 4 and 7A only</td></tr>
<tr><td colspan="2">Recommended Text</td><td colspan="6">S.Karlin and H.M. Taylor, A first course in stochastic processes (2nd edition) Academic Press, New York, 1975</td></tr>
</table>

Reference Books	1. E. Cinler, *Introduction to stochastic processes*, Prentice Hall Inc, New Delhi, 1975 2. D.R.Cox and H.D.Miller, *Theory of stochastic processes* (3rd Edition) Chapman and hall, London, 1983 3. D.Kannan, *An introduction to stochastic processes*, North-Holland, New York, 1979 4. S.M. Ross, *Stochastic processes*, John Wiley and Sons, New York, 1983 5. H.W. Taylor nd S.Karlin, *An introduction to stochastic modelling* (3rd Edition), Academic Press, New York, 1998

ourse Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO 1: Define Markov chain and Transition probability matrix.

CLO 2: Understand the concepts of queuing models and limit theorems on Markov chains.

CLO 3: Explain about the pure birth , death processes and Poisson process.

CLO 4: Acquire the knowledge of some special Renewal processes.

CLO 5: Describe the joint probabilities for Brownian motion.

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

Title of the Course		**3.6: TERM PAPER & SEMINAR PRESENTATION**					
Paper Number		Skill Enhancement Course - II					
Category	SEC	Year	**II**	Credits	**2**	Course Code	
		Semester	**III**				
Instructional Hours per week		Lecture	Tutorial		Lab Practice		Total
		3	-		-		**3**

Title of the Course		**3.7. INTERNSHIP / INDUSTRIAL ACTIVITY**					
Category		Year	**II**	Credits	**2**	Course Code	
		Semester	**III**				
Instructional Hours per week		Lecture	Tutorial		Lab Practice		Total

SEMESTER – IV

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">4.1: FUNCTIONAL ANALYSIS</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">CORE - XI</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>IV</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>4</td><td colspan="2">2</td><td colspan="2">--</td><td colspan="2">6</td></tr>
<tr><td colspan="2">Prerequisite</td><td colspan="8">Elements of Real Analysis</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="8">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.</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="8">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</td></tr>
<tr><td colspan="8">UNIT-II : Hilbert Spaces: The definition and some simple properties–Orthogonal complements–Orthonormal sets–The conjugate space H^*-The adjoint of an operator–self-adjoint operators-Normal and unitary operators – Projections.
Chapter10:Section 52-59</td></tr>
<tr><td colspan="8">UNIT-III : Finite-Dimensional Spectral Theory: Matrices – Determinants and the spectrum of an operator –The spectral theorem.
Chapter 11:Sections 60-62</td></tr>
<tr><td colspan="8">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</td></tr>
<tr><td colspan="8">UNIT-V: The Structure of Commutative Banach Algebras: The Gelfand mapping – Application of the formula $r(x) = \lim \|x^n\|^{1/n}$– Involutions in Banach algebras-The Gelfand-Neumark theorem.
Chapter 13:Sections 70-73.</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 Transferable Skill</td></tr>
</table>

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.

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

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">4.2: DIFFERENTIAL GEOMETRY</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">CORE - XII</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" colspan="2"></td></tr>
<tr><td>Semester</td><td>IV</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 colspan="2">Total</td></tr>
<tr><td colspan="2">4</td><td colspan="2">2</td><td colspan="2">--</td><td colspan="2">6</td></tr>
<tr><td colspan="2">Prerequisite</td><td colspan="8">Linear Algebra concepts and Calculus</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="8">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</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="8">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.</td></tr>
<tr><td colspan="8">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.</td></tr>
<tr><td colspan="8">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.</td></tr>
<tr><td colspan="8">UNIT-IV : Non Intrinsic properties of a surface:The second fundamental form- Principal 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.</td></tr>
<tr><td colspan="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).</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 Transferable Skill</td></tr>
<tr><td colspan="2">Recommended Text</td><td colspan="8">T.J.Willmore, An Introduction to Differential Geometry, Oxford University Press,(17th Impression) New Delhi 2002. (Indian Print)</td></tr>
</table>

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

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

Title of the Course		**4.3: PROJECT WITH VIVA VOCE**						
Paper Number								
Category		Year	**II**	Credits	**7**	Course Code		
		Semester	**IV**					
Instructional Hours per week		Lecture		Tutorial		Lab Practice	Total	
		-		-		-	**10**	

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">4.4.1: PROGRAMMING IN C++ PRACTICAL</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">ELECTIVE - VI</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>IV</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>–</td><td colspan="2">–</td><td colspan="2">5</td><td colspan="2">5</td></tr>
<tr><td colspan="2">Prerequisite</td><td colspan="8">Basic functionality of computer programs.</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="8">This course introduces a higher level language C++ for hands-on experience on computers.</td></tr>
<tr><td colspan="2">Course Outline</td><td colspan="8">LIST OF PRACTICALS IN PROGRAMMING IN C++
1. Vector Representation using Class
2. Sum of two types of objects
3. String Class
4. Matrix Operations using Operator Overloading
5. Overloaded = = Operator for String Comparison
6. Conversion from Polar to Rectangle and Rectangle to Polar
7. Friend Function
8. Virtual Function
9. Extending Shape class to find area of circle
10. Text Process
11. Text file process
12. Creating data file with name and phone numbers
13. Creation and Process of telephone files</td></tr>
<tr><td colspan="2">Recommended Text</td><td colspan="8">1. E. Balagurusamy, Object Oriented Programming with C++, Tata McGraw Hill, New Delhi, (1999).
2. V.Ravichandran, Programming with C++, Second Edition Tata McGraw- Hill, New Delhi, 2006.</td></tr>
<tr><td colspan="2">Reference Books</td><td colspan="8">1. D. Ravichandran, Programming with C++, Tata McGraw Hill, New Delhi, (1996)
2. Conte and de Boor, Numerical Analysis, McGraw Hill, New York, (1990)
3. John H.Mathews, Numerical Methods for Mathematics, Science and Engineering (2nd Edn.), Prentice Hall, New Delhi, (2000)
4. Devi Prasad, An Introduction to Numerical Analysis (3rd edn) Narosa Publishing House, New Delhi, (2006).</td></tr>
</table>

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO 1: Understanding about object oriented programming. Learn how to store one object inside another object

CLO 2: Gain knowledge about the capability to store information together in an object.

CLO 3: Understand the capability of a class to rely upon another class. Learn use of one method can be used in variety of different ways

CLO 4: Understanding the process of exposing the essential data to the outside of the world and hiding the low level data .Create and process data in files using file I/O functions

CLO 5: Understand about constructors which are special type of functions. Discuss to know about writing style

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

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">4.4.2: MATHEMATICAL PYTHON - PRACTICAL</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">ELECTIVE - VI</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>IV</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="2">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>–</td><td>–</td><td colspan="2">5</td><td colspan="2">5</td></tr>
<tr><td colspan="2">Prerequisite</td><td colspan="6">Basic computer skills, mathematical problem solving</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">To Apply basic Python and numpy to solve mathematical problems, Graphical representation and manipulation of data using python</td></tr>
<tr><td colspan="2">Course Outline</td><td colspan="6">LIST OF PRACTICALS IN MATHEMATICAL PYTHON:
1. Find minimum/maximum in a list / guess an integer in given range
2. Distance between two points
3. Find GCD
4. Sum an array of numbers
5. Linear search
6. Binary search.
7. Find the numbers which are divisible by n in a given range
8. Print first n Fibonacci numbers
9. Selection sort
10. Insertion sort
11. Merge sort
12. Count word frequencies
13. Generate adjacency matrix of any graph on n vertices
14. Find degree of vertices from given adjacency matrix of the graph
15. Find odd number in given array/ Replace odd numbers with given integer in the given array
16. Compute multiplication of two 3x3 matrices
17. Compute mean and standard deviation of given array
18. Create a Barplot/Piechart for comparing three features.</td></tr>
<tr><td colspan="2">Recommended Text</td><td colspan="6">Allen B. Dowley, Think Python: How to Think Like a Computer Scientist, 2nd Edition.</td></tr>
<tr><td colspan="2">Reference Books</td><td colspan="6">1. Wes McKinney, Python for Data Analysis: Data Wrangling with Pandas, NumPy, and Ipython, O'Reilly, 2nd Edition, 2018.
2. Jake VanderPlas, Python Data Science Hand Book: Essential Tools for working with Data, O'Reilly, 2017.
3. Wesley J. Chun, Core Python Programming, Prentice Hall, 2006.
4. N.Safina Devi and C.Devamanoharan, Algorithmic Problem Solving and Python- A Beginner's Guide, Francidev Publications, 2023.</td></tr>
</table>

Course Learning Ou. tcome (for Mapping with POs and PSOs)

Students will be able to

CLO 1: Write programs using advanced concepts of Python.
CLO 2: Write, Test and Debug Python Programs.
CLO 3: Implement Conditionals and Loops for Python Programs.
CLO 4: Use functions and represent Compound data using Lists, Tuples and Dictionaries.
CLO 5: Read, write and manipulate data from & to files in Python.

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

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">4.4.3: RESEARCH METHODOLOGY</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">ELECTIVE - VI</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>IV</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>Total</td></tr>
<tr><td>4</td><td colspan="2">1</td><td colspan="2">-</td><td>5</td></tr>
<tr><td colspan="2">Prerequisite</td><td colspan="6">Basic knowledge in Research problems and related information to be useful for Research.</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">To understand the Basic aspects in Research, to learn Mathematical Technique for Research and to acquire basic knowledge about various instruments in Mathematical Research.</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="6">UNIT I : To know about writing style - Writing clearly and concisely-Level of formality - Using gender- neutral language-reading other research project
Chapter 3: Section 3.1 – 3.4</td></tr>
<tr><td colspan="6">UNIT II : Tips and Strategies-Planning carefully-Deciding on your writing approach- Sourcing and selecting information - Recording information/making notes
Chapter 4: Section 4.1 – 4.4.</td></tr>
<tr><td colspan="6">UNIT III: Research Project: Research Project – Difference between a dissertation and a thesis - Basic requirements of research degree – Writing a proposal – Ethical considerations
Chapter 5 ; Sec 5.1, 5.2, 5.3, 5.6,5.13</td></tr>
<tr><td colspan="6">UNIT IV: Different components of a Research Project – Title page – Abstract- Acknowledgement - List of Contents – Introduction-Literature Review -Methodology – Style of Presentation – Conclusions–Bibliography–Appendices.
Chapter 6: Section 6.1 – 6.4, 6.6, 6.7, 6.8.1, 6.9.1, 6.11 – 6.13</td></tr>
<tr><td colspan="6">UNIT V :Publishing and presenting your research and Tool kit-Journal Articles - A book - conference presentation- A final note - All punctuations.
Chapters 7 & 8</td></tr>
<tr><td colspan="2">Recommended Text</td><td colspan="6">Writing up your University Assignments and Research Projects – A Practical Handbook, Neil Murray and Geraldine Hughes, McGraw Hill Open University Press.</td></tr>
</table>

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO1: Discuss to know about writing style

CLO2: Discuss the Tips and Strategies

CLO3: To know about the research project
CLO4: Discuss the different components of Research Project
CLO5: To learn the Publication and presentation of research articles and Tool kits

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

Title of the Course		**4.5: TRAINING FOR COMPETITIVE EXAMINATIONS**					
Paper Number		Skill Enhancement Course - III Professional Competency Skill Enhancement					
Category	SEC	Year	**II**	Credits	**2**	Course Code	
		Semester	**IV**				
Instructional Hours per week		Lecture	Tutorial		Lab Practice		Total
							3
Course Outline		Mathematics for NET/UGC-CSIR,TRB Competitive Examinations					

Title of the Course		**4.6: EXTENSION ACTIVITY**					
Paper Number							
Category		Year	**II**	Credits	**1**	Course Code	
		Semester	**IV**				
Instructional Hours per week		Lecture	Tutorial		Lab Practice		Total
Course Outline		Syllabus will be prepared by the University as a common course to all PG Programmes.					