M.Sc.

MATHEMATICS

SYLLABUS

FROM THE ACADEMIC YEAR
2025-26

DEPARTMENT OF MATHEMATICS

ANNAMALAI UNIVERSITY

CONTENTS

1. Preamble

There are four different modes of imparting education: Outcome Based Education, Problem Based Education, Project Based Education and Industry Aligned Education.

Taxonomy forms three learning domains: the cognitive (knowledge), affective (attitude), and psychomotor (skill). This classification enables 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 student's 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

2. Structure of the Programme

Post Graduate Program in Mathematics: M.Sc. (Mathematics)

The period of the program is two years with four semesters. Each semester has core courses, elective courses and skill courses. The evaluation of each course is based on internal evaluation and end semester written examination. The curriculum is based on learning outcome both based on Programme and Specific Programme

2.1 Learning Objectives

a. Programme Outcomes(Science):

PO1: Disciplinary Knowledge: Capable of demonstrating comprehensive knowledge and understanding of one or more disciplines that form a part of a Post graduate programme of study.

PO2: Critical Thinking: Capability to apply analytic thought to a body of knowledge; analyse and evaluate evidence, arguments, claims, beliefs on the basis of empirical evidence; identify

relevant assumptions or implications; formulate coherent arguments; critically evaluate practices, policies and theories by following scientific approach to knowledge development.

PO3: Problem Solving: Capacity to extrapolate from what one has learned and apply their competencies to solve different kinds of non-familiar problems, rather than replicate curriculum content knowledge; and apply one's earning to real life situations.

PO4: Analytical & Scientific Reasoning: Ability to evaluate the reliability and relevance of evidence; identify logical flaws and holes in the arguments of others; analyze and synthesize data from a variety of sources; draw valid conclusions and support them with evidence and examples and addressing opposing viewpoints.

PO5: Research related skills: Ability to analyse, interpret and draw conclusions from quantitative / qualitative data; and critically evaluate ideas, evidence, and experiences from an open minded and reasoned research perspective; Sense of inquiry and capability for asking relevant questions / problem arising / synthesizing / articulating / ability to recognize cause and effect relationships / define problems. Formulate hypothesis, Test / analyse / interpret the results and derive conclusion, formulation and designing mathematical models

PO6: Self-directed & Lifelong Learning: Ability to work independently, identify and manage a project. Ability to acquire knowledge and skills, including "learning how to learn", through self-placed and self-directed learning aimed at personal development, meeting economic, social and cultural objectives.

b. Programme Specific Outcomes(Mathematics):

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

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

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

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

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

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

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

2.2 . Structure of the Course

Course Code	**Course Name**		**Credits**
Lecture Hours: (L) per week	**Tutorial Hours : (T) per week**	**Lab Practice Hours: (P)per week**	**Total: (L+T+P) per week**
Course Category :	**Year & Semester:**	**Admission Year:**	
Pre-requisite			
Links to other Courses			
Learning Objectives: (for teachers: what they have to do in the class/lab/field)			
Course Outcomes: (for students: To know what they are going to learn) **CO1:** **CO2:** **CO3:** **CO4:** **CO5:**			
Recap: (not for examination) Motivation/previous lecture/ relevant portions required for the course) [This is done during 2 Tutorial hours)			
Units	**Contents**		**Required Hours**
I			**18**
II			**18**
III			**18**
IV			**18**
V			**18**
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)		

Skills acquired from the course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill	
Learning Resources: • **Recommended Texts** • **Reference Books** • **Web resources**		
Board of Studies Date:		

3. Teaching Methodologies

Traditional Teaching method like Chalk and Board, Virtual Class room, 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.

4. Learning and Teaching Activities

4.1 Topic wise Delivery method

Hour Count	Topic	Unit	Mode of Delivery

4.2 Work Load

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

Activity	Quantity	Workload periods

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

4.3 Tutorial Activities

Tutorial Count	Topic

4.4 Laboratory Activities

Experiment Count	Topic

4.5 Field Study Activities

Date	Activity

4.6 Assessment Activities

4.6.1 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.

4.6.2 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%

5. Faculty Course File Structure

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

6. **Template for M.Sc.,Mathematics**

Semester–I	**Credit**	**Hours**	**Semester-II**	**Credit**	**Hours**	**Semester-III**	**Credit**	**Hours**	**Semester–IV**	**Credit**	**Hours**
1.1. Core-I	5	7	2.1. Core-IV	5	6	3.1. Core-VIII	5	6	4.1. Core-XI	5	6
1.2 Core-II	5	7	2.2 Core-V	5	6	3.2 Core-IX	5	6	4.2 Core-XII	5	6
1.3 Core – III	4	6	2.3 Core – VI	4	5	3.3 Core – X	5	6	4.3 Generic Elective -V:	3	4
1.4 Discipline Centric Elective -I	3	5	2.4 Core - VII	4	5	3.4 Discipline Centric Elective - IV	3	5	4.4Elective-VI (Industry / Entrepreneurship) 20% Theory 80% Practical	3	4
1.5 Generic Elective-II:	3	5	2.5 Discipline Centric Elective – III	3	4	3.5 Skill Enhancement II	2	3	4.5 Skill Enhancement course / Professional Competency Skill	2	3
			2.6 Skill Enhancement I	2	4	3.6 Internship/ Industrial Activity Course/Industrial Activity	2	4	4.3 Project with viva voce	7	7
									4.6 Extension Activity	1	
	20	**30**		**23**	**30**		**22**	**30**		**26**	**30**
Total Credit Points -91											

6.1 Course Structure for M.Sc. Mathematics

Year	Semester	Part	Course	Credit	Hours/Week (L+T+P)
I	I	A	CC1 - Algebraic Structures	5	7 (6+1+0)
			CC2 - Real Analysis I	5	7 (6+1+0)
			CC3 - Ordinary Differential Equations	4	6 (5+1+0)
			Elective-I(Generic/Discipline Specific)(One from GroupA) Graph Theory and Applications	3	5 (4+1+0)
			Elective II(Generic / Discipline Specific)(One from Group B) Discrete Mathematics	3	5(4+1+0)
			Total	**20**	**30**
	II	A	CC4 – Advanced Algebra	5	6 (5+1+0)
			CC5 – Real Analysis II	5	6 (5+1+0)
			CC6 - Partial Differential Equations	4	5 (4+1+0)
			CC7 –Differential Geometry	4	5(4+1+0)
			Elective-III(Computer/IT related) (One from Group D) Calculus of Variations and Integral Equations	3	4 (3+1+0)
		B	Skill Enhancement Course – I Mathematical documentation using LATEX	2	4 (2+0+2)
			Total	**23**	**30**
II	III	A	CC8 - Complex Analysis	5	6 (5+1+0)
			CC9 - Probability Theory	5	6 (5+1+0)
			CC10 – Topology	5	6 (5+1+0)
			Elective IV(Generic / Discipline Specific)(One from Group E) Stochastic Processes	3	5 (4+1+0)
		B	Skill Enhancement Course – II Programming in C++ with practical	2	3 (2+0+1)
			Internship/Industrial Activity / Industrial Activity Course Introduction to MATLAB	2	4(2+1+1)
			Total	**22**	**30**
	IV	A	CC11–Functional Analysis	5	6 (5+1+0)

			CC12–Mechanics	5	6 (5+1+0)
			Elective V (Generic / Discipline Specific)(One from Group C) Mathematical Statistics	3	4 (3+1+0)
			Elective VI(Industry/ Entrepreneurship Course) Optimization Technique	3	4 (3+1+0)
			Project with viva voce	7	7
		B	Skill Enhancement Course III / Professional Competency Training for Competitive Examinations • Mathematics for NET / UGC - CSIR/ SET / TRB Competitive Examinations (2 hours) • General Studies for UPSC / TNPSC / Other Competitive Examinations (2 hours) OR Mathematics for Advanced Research Studies (4 hours)	2	4 (3+1+0)
		C	Extension Activity	1	--
			Total	**26**	**30**
			Total Credit Points	**91**	

6.2 Consolidated Table for Credits Distribution

	Category of Courses	Credits for each Course	Number of Courses	Number of Credits in each Category of Courses	Total Credits	Total Credits for the Programme
PART A	Core		12	57	82	88 (CGPA)
	Project with viva voce		1	7		
	Industry aligned Programmes-	3	1	3		
	Elective (Generic and Discipline Centric)	3	5	15		

PART B (i)	Skill Enhancement (Term paper and Seminar &Generic / Discipline -Centric Skill Courses) (Internal Assessment Only)	2	3	6	6	
PART B (ii)	Summer Internship/Industrial Activity Course	2	1	2	2	3 (Non CGPA)
PART C	Extension Activity	1	1	1	1	
						91

7. **Template for Semester**

Code	**Category**	**Title of the Paper**	**Marks (Max 100)**		**Duration for UE**	**Credits**
			CIA	**UE**		
Semester –I						
Part A	Core I		25	75	3Hrs	5
	Core II		25	75	3Hrs	5
	Core III		25	75	3Hrs	4
	Elective I	Elective-I (One from Group-A)	25	75	3Hrs	3
	Elective II	Elective-I I (One from Group-B)	25	75	3Hrs	3
Semester-II						
Part A	Core IV		25	75	3Hrs	5
	Core V		25	75	3Hrs	5
	Core VI		25	75	3Hrs	4
	Core VII		25	75	3 Hrs	4
	Elective III	Elective-III (One from Group-C)	25	75	3Hrs	3

Part B	Skill Enhancement Course -I	(One from Group-G)	Internal Assessment			2
Semester-III						
	Core VIII		25	75	3Hrs	5
	Core IX		25	75	3Hrs	5
	Core X		25	75	3Hrs	5
	Elective IV	Elective-IV (One from Group-E)	25	75	3Hrs	3
Part B						
	Skill Enhancement Course II	Internal Assessment				2
	Internship/Industrial vacation Activity / Industrial Oriented Courses/ Internal Assessment					2
Semester-IV						
	Core XI		25	75	3 Hrs	5
	Core XII		25	75	3 Hrs	5
	Elective V	Elective V(One from Group C)	25	75	3 Hrs	3
	Elective VI	Elective-VI Industry/Entrepreneurship	25	75	3 Hrs	3
	Project with viva voce		25	75		7
Part B	Skill Enhancement Course	Professional Competency/Skill Enhancement Course	Internal Assessment			2
Part C	Extension Activity	Performance based assessment				1
					Total Credits	**91**

Extra Disciplinary Courses for other Departments (not for Mathematics students)

Students from other Departments may also choose any one of the following as Extra Disciplinary Course.

ED-I: Numerical Methods

ED-II: Discrete Mathematics

8. **Instructions for Course Transaction**

Courses	Lecture	Tutorial	Lab Practice	Total

	hrs	hrs		hrs
Core	61	12	--	73
Electives	18	05	--	23
ED	06	02	--	08
Lab Practice Courses	45	15	30	90
Project	07	--	70	07
Industrial Oriented Course	3	1	-	4
Skill Enhancement Course	4	1	2	7
Professional Competency Course	3	1	-	4

9. **Testing Pattern (25+75)**

Internal Assessment

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

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

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

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

Question paper Model

Intended Learning Skills	**Maximum 75 Marks** **Passing Minimum: 50%** **Duration : Three Hours**
	Part –A(10x 2 = 20 Marks) Answer ALL questions **Each Question carries 2mark**

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

Each question should carry the course outcome and cognitive level

For instance,

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

10. Different Types of Courses

(i) Core Courses

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

(iii) Elective Courses (ED from other Department Experts)

(iv) Skill Development Courses

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

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

11. Syllabus for different Courses of M. Sc. Mathematics

11.1 Core Courses

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">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">25MATC101</td></tr>
<tr><td>Semester</td><td>I</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td colspan="2">Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td colspan="2">6</td><td colspan="2">1</td><td colspan="2">--</td><td>7</td></tr>
<tr><td colspan="2">Pre-requisite</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, Second proof only).
Chapter 2: Sections 2.11 and 2.12</td></tr>
<tr><td colspan="8">UNIT-II: Solvable groups-Direct products-Finite abelian groups-Modules.
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: Rings-Euclidean rings and Polynomial rings.
Chapter 3: Sections 3.7, 3.8,3.9 and 3.10</td></tr>
<tr><td colspan="8">UNIT-IV: Linear Transformations: Canonical forms-Triangular form-Nilpotent transformations-Jordan form.
Chapter 6: Sections 6.4,6.5 and 6.6.</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">Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)</td><td colspan="8">Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved
(To be discussed during the Tutorial hour)</td></tr>
<tr><td colspan="2">Skills acquired from this course</td><td colspan="8">Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill</td></tr>
<tr><td colspan="2">Recommended Text</td><td colspan="8">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, and 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="6">REAL ANALYSIS I</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">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">25MATC102</td></tr>
<tr><td>Semester</td><td>I</td></tr>
<tr><td colspan="2">Instructional Hours per week</td><td>Lecture</td><td>Tutorial</td><td>Lab Practice</td><td colspan="3">Total</td></tr>
<tr><td colspan="2"></td><td>6</td><td>1</td><td>--</td><td colspan="3">7</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">UG level real analysis concepts</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">To work comfortably with functions of bounded variation, Riemann-Stieltjes Integration, convergence of infinite series, infinite product and uniform convergence and its interplay between various limiting operations.</td></tr>
<tr><td colspan="2" rowspan="2">Course Outline</td><td colspan="6">UNIT-I : Functions of bounded variation - Introduction - Properties of monotonic functions - Functions of bounded variation - Total variation - Additive property of total variation - Total variation on [a, x] as a function of x - Functions of bounded variation expressed as the difference of two increasing functions - Continuous functions of bounded variation.
Chapter – 6:Sections 6.1 to 6.8
Infinite Series: Absolute and conditional convergence - Dirichlet's test and Abel's test - Rearrangement of series - Riemann's theorem on conditionally convergent series.
Chapter 8:Sections 8.8, 8.15, 8.17, 8.18</td></tr>
<tr><td colspan="6">UNIT-II :The Riemann - Stieltjes Integral - Introduction - Notation - The definition of the Riemann - Stieltjes integral - Linear Properties - Integration by parts- Change of variable in a Riemann - Stieltjes integral - Reduction to a Riemann Integral – Euler’s summation formula - Monotonically increasing integrators, Upper and lower integrals - Additive and linearity properties of upper, lower integrals - Riemann's condition - Comparison theorems.
Chapter - 7:Sections 7.1 to 7.14</td></tr>
</table>

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

Reference Books	1. Bartle, R.G. *Real Analysis*, John Wiley and Sons Inc., 1976. 2. Rudin,W. *Principles of Mathematical Analysis*, 3rd Edition. McGraw Hill Company, New York, 1976. 3. Malik,S.C. and Savita Arora. *Mathematical Anslysis*, Wiley Eastern Limited.New Delhi, 1991. 4. Sanjay Arora and BansiLal, *Introduction to Real Analysis*, SatyaPrakashan, 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

Title of the Course		**ORDINARY DIFFERENTIAL EQUATIONS**					
Paper Number		**CORE III**					
Category	Core	**Year**	I	**Credits**	4	**Course Code**	**25MATC103**
		Semester	I				
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
		5	1	--	6		
Pre-requisite		UG level Calculus and Differential Equations					

Objectives of the Course	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
Course Outline	**UNIT-I : Linear equations with constant coefficients** Second order homogeneous equations-Initial value problems-Linear dependence and independence-Wronskian and a formula for Wronskian-Non-homogeneous equation of order two. **Chapter 2: Sections 1 to 6**
	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**.
	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)**
	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)**
	UNIT-V: Existence and uniqueness of solutions to first order equations: Equation with variable separated – Exact equation – method of successive approximations – the Lipschitz condition – convergence of the successive approximations and the existence theorem. **Chapter 5 : Sections 1 to 6 (Omit Sections 7 to 9)**
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Recommended Text	E.A.Coddington, *A introduction to ordinary differential equations* (3rd Printing) Prentice-Hall of India Ltd.,New Delhi, 1987.
Reference Books	1. Williams E. Boyce and Richard C. DI Prima, *Elementary differential equations and boundary value problems*,John Wiley and sons, New York, 1967. 2. George F Simmons, *Differential equations with applications and historical notes,* Tata McGraw Hill, New Delhi, 1974. 3. N.N. Lebedev, *Special functions and their applications*, Prentice Hall of India, New Delhi, 1965. 4. W.T. Reid. *Ordinary Differential Equations*, John Wiley and Sons, New York, 1971 5. M.D.Raisinghania, *Advanced Differential Equations*, S.Chand& Company Ltd. New Delhi 2001 6. B.Rai, D.P.Choudary and H.I. Freedman, *A Course in Ordinary Differential Equations,* Narosa Publishing House, New Delhi, 2002.
Website and e-Learning Source	http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics, http://www.opensource.org, www.mathpages.com

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

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

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

CLO3: Analyze solutions using appropriate methods and give examples.

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

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

	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">ADVANCED ALGEBRA</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">CORE IV</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">5</td><td rowspan="2">Course Code</td><td rowspan="2">25MATC201</td></tr>
<tr><td>Semester</td><td>II</td></tr>
<tr><td colspan="2">Instructional Hours per week</td><td>Lecture</td><td>Tutorial</td><td>Lab Practice</td><td colspan="3">Total</td></tr>
<tr><td colspan="2"></td><td>5</td><td>1</td><td>--</td><td colspan="3">6</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">Algebraic Structures</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">To study field extension, roots of polynomials, Galois Theory, finite fields, division rings, solvability by radicals and to develop computational skill in abstract algebra.</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="6">UNIT-I: Vector Spaces: Linear independence and bases, dual space, Extension fields.
Chapter 4: Sections 4.1, 4.2 and 4.3
Chapter 5: Section 5.1</td></tr>
<tr><td colspan="6">UNIT-II: Transcendence of e. Roots or Polynomials- More about roots.
Chapter 5: Sections 5.2, 5.3 and 5.5</td></tr>
<tr><td colspan="6">UNIT-III: Elements of Galois theory.
Chapter 5: Section 5.6</td></tr>
<tr><td colspan="6">Unit-IV: Finite fields- Wedderburn’s theorem on finite division rings.
Chapter 7: Sections 7.1 and 7.2 (Theorem 7.2.1 only)</td></tr>
<tr><td colspan="6">UNIT-V: Solvability by radicals- A theorem of Frobenius- Integral Quaternions and the Four- Square theorem.
Chapter 5: Section 5.7(omit Lemma 5.7.1, Lemma 5.7.2 and Theorem 5.7.1)
Chapter 7: Sections 7.3 and 7.4</td></tr>
<tr><td colspan="2">Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)</td><td colspan="6">Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved
(To be discussed during the Tutorial hour)</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 Transferrable Skill</td></tr>
<tr><td colspan="2">Recommended Text</td><td colspan="6">I.N. Herstein. Topics in Algebra (II Edition) Wiley EasternLimited, 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 Hindustan Publishing Company, New Delhi.
Website and e-Learning Source	http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics, http://www.opensource.org, www.algebra.com

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO1: Prove theorems applying algebraic ways of thinking.

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

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

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

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

	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		**REAL ANALYSIS II**					
Paper Number		**CORE V**					
Category	Core	**Year**	I	**Credits**	5	**Course Code**	**25MATC202**
		Semester	II				
Instructional		**Lecture**		**Tutorial**		**Lab Practice**	**Total**

Hours per week	5	1	--	6
Pre-requisite	Elements of Real Analysis			
Objectives of the Course	To introduce measure on the real line, Lebesgue measurability and integrability, Fourier Series and Integrals, in-depth study in multivariable calculus.			
Course Outline	**Unit-I:** Lebesgue Outer measure, Measurable sets, Regularity, Measurable functions, Borel and Lebesgue measurability. **Chapter 2: Sections 2.1 to 2.5**			
	Unit-II: Integration of nonnegative functions, General integral, Integration of series, Riemann and Lebesgue integrals. **Chapter 3: Sections 3.1 to 3.4**			
	Unit-III: Continuous non-differentiable functions, Lebesgue differential theorem (statement only), Differentiation and Integration, Lebesgue set, Convergence in measure, Almost uniform Convergence. **Chapter 4: Sections 4.2, 4.4 to 4.6** **Chapter 7: Sections 7.1 and 7.2**			
	Unit–IV: Measures and outer measures, Extension of a measure, Uniqueness of the extension, Completion of a measure, Measure spaces, Integration with respect to a measure. **Chapter 5: Sections 5.1 to 5.6**			
	Unit-V: L^L Spaces, Convex functions, Jensen's inequality, The inequalities of Holder and Minkowski, Completeness of $L^L(L)$. **Chapter 6: Sections 6.1 to 6.5.**			
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)			
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill			
Recommended Text	1. G. de Barra, *Measure Theory and Integration*, Wiley Eastern Ltd., New Delhi, 1981.			

Reference Books	1. Burkill,J.C.*TheLebesgue Integral*, Cambridge University Press, 1951. 2. Tom M.Apostol :*Mathematical Analysis*, 2nd Edition, Addison-Wesley Publishing Company Inc. New York, 1974. 3. Munroe,M.E.*Measure and Integration*. Addison-Wesley, Mass.1971. 4. Roydon,H.L.*Real Analysis*, Macmillan Pub. Company, New York, 1988. 5. Rudin, W. *Principles of Mathematical Analysis*, McGraw Hill Company, New York,1979. 6. Malik,S.C. and Savita Arora. *Mathematical Analysis,* Wiley Eastern Limited. New Delhi, 1991. 7. Sanjay Arora and BansiLal, *Introduction to Real Analysis*, SatyaPrakashan, New Delhi, 1991
Website and e-Learning Source	http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics, http://www.opensource.org

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

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

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

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

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

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

	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		**PARTIAL DIFFERENTIAL EQUATIONS**					
Paper Number		**CORE VI**					
Category	Core	**Year**	I	**Credits**	4	**Course**	**25MATC203**

		Semester	II			**Code**	
Instructional Hours per week		**Lecture**		**Tutorial**	**Lab Practice**		**Total**
		4		1	--		5
Pre-requisite		UG level partial differential equations					
Objectives of the Course		To classify the second order partial differential equations and to study Cauchy problem, method of separation of variables, boundary value problems.					
Course Outline		**Unit I:** Partial Differential Equations of the First order: Partial Differential Equations-Origins of First-order Partial Differential Equations-Cauchy's Problem for First-order Equations-Linear Equations of the First-order-Integral Surfaces Passing through a Given Curve-Surfaces Orthogonal to a Given System of Surfaces. **Chapter 2: Sections 1 to 6**					
		Unit II: Non-Linear First order Partial Difference Equations: Cauchy's Method of Characteristics- Compatible Systems of First-order Equations-Charpit's Method-Special Types of First-order Equations -Jacobi's Method. **Chapter 2: Sections 7 to 11 and 13**					
		Unit III: Second order Partial Differential Equations: Linear Partial Differential Equations with Constant Coefficients-Equations with Variable Coefficients-The Method of Integral Transforms-Separation of Variables **Chapter 3: Sections 4,5 and 9,10**					
		Unit IV: Laplace Equations: Elementary Solutions of Laplace's Equations- Families of Equipotential Surfaces- Boundary value Problems- Separation of Variables- Problems with Axial Symmetry-Two Dimensional Laplace Equations. **Chapter 4: Sections 2,3,4,5,6 and 11**					
		Unit V: The Wave Equation and Diffusion Equation: The Elementary Solutions of the One-dimensional Wave Equation-The Riemann-Volterra Solution of the One-dimensional Wave Equation-Three-dimensional Problems-Elementary Solutions of Diffusion Equation-Separation of Variables. **Chapter 5: Sections 2,3 and 5** **Chapter 6: Sections 3 and 4**					

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	I.N. Sneddon, Elements of Partial Differential Equations, McGraw Hill, International Edition, Singapore, (1986)
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 6. TynMyint-U and LokenathDebnath, *Partial Differential Equations for Scientists and Engineers* (Third Edition), North Hollan, New York, 1987.
Website and e-Learning Source	http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics, http://www.opensource.org, www.mathpages.com

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

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

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

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

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

CLO5: To apply Green's function and solveDirichlet, 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

Title of the Course	**DIFFERENTIAL GEOMETRY**					
Paper Number	**CORE VII**					
Category Core	**Year** I	**Credits** 4	**Course Code** **25MATC204**			
	Semester II					
Instructional Hours per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
	5	1	--	6		
Pre-requisite	Linear Algebra concepts and Calculus					
Objectives of the Course	This course introduces space curves and their intrinsic properties of a surface and geodesics. Further the non-intrinsic properties of surface and the differential geometry of surfaces are explored					
Course Outline	**UNIT-I : Space curves:** Definition of a space curve – Arc length – tangent – normal and binormal – curvature and torsion – contact between curves and surfaces- tangent surface- involutes and evolutes- Intrinsic equations – Fundamental Existence Theorem for space curves- Helies. **Chapter I: Sections 1 to 9.**					
	UNIT-II: Intrinsic properties of a surface: Definition of a surface – curves on a surface – Surface of revolution – Helicoids – Metric- Direction coefficients – families of curves- Isometric correspondence- Intrinsic properties. **Chapter II: Sections 1 to 9.**					
	UNIT-III: Geodesics: Geodesics – Canonical geodesic equations – Normal property of geodesics- Existence Theorems – Geodesic parallels – Geodesics curvature- Gauss- Bonnet Theorem – Gaussian curvature- surface of constant curvature. **Chapter II: Sections 10 to 18.**					
	UNIT-IV: Non Intrinsic properties of a surface: The second fundamental form- Principle curvature – Lines of curvature – Developable - Developable associated with space curves and with curves on surface - Minimal surfaces – Ruled surfaces. **Chapter III: Sections 1 to 8.**					

	UNIT-V :Differential Geometry of Surfaces : Compact surfaces whose points are umblics- Hilbert's lemma – Compact surface of constant curvature – Complete surface and their characterization – Hilbert's Theorem – Conjugate points on geodesics. **Chapter IV : Sections 1 to 8 (Omit 9 to 15).**
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	T.J.Willmore, *An Introduction to Differential Geometry,* Oxford University Press,(17th Impression) New Delhi 2002. (Indian Print)
RefereEce Books	1.1 Struik, D.T. *Lectures on Classical Differential Geometry*, Addison – Wesley, Mass. 1950. 1.2 Kobayashi. S. and Nomizu. K. *Foundations of Differential Geometry,* Interscience Publishers, 1963. 1.3 Wilhelm Klingenberg: *A course in Differential Geometry*, Graduate Texts in Mathematics, Springer-Verlag 1978. 1.4 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

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">COMPLEX ANALYSIS</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">25MATC301</td></tr>
<tr><td>Semester</td><td>III</td></tr>
<tr><td colspan="2">Instructional Hours per week</td><td>Lecture</td><td>Tutorial</td><td>Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td colspan="2"></td><td>5</td><td>1</td><td>--</td><td colspan="2">6</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">UG level Complex Analysis</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">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="3">Course Outline</td><td colspan="6">UNIT-I :Cauchy's Integral Formula: The Index of a point with respect to a closed curve – The Integral formula – Higher derivatives. Local Properties of analytical Functions:
Removable Singularities-Taylors's Theorem – Zeros and poles – The local Mapping – The Maximum Principle.
Chapter 4 : Section 2 : 2.1 to 2.3
Chapter 4 : Section 3 : 3.1 to 3.4</td></tr>
<tr><td colspan="6">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="6">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>
</table>

	UNIT-IV :Harmonic Functions and Power Series Expansions: Schwarz theorem - The reflection principle - Weierstrass theorem – Taylor's Series – Laurent series . **Chapter 4 : Sections 6.4 and 6.5** **Chapter 5 : Sections 1.1 to 1.3**
	UNIT-V: Partial Fractions and Entire Functions: Partial fractions - Infinite products – Canonical products – Gamma Function- Jensen's formula – Hadamard's Theorem **Chapter 5 : Sections 2.1 to 2.4** **Chapter 5 : Sections 3.1 and 3.2**
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	Lars V. Ahlfors, *Complex Analysis*, (3rd edition) McGraw Hill Co., New York, 1979
Reference Books	1. H.A. Presfly, *Introduction to complex Analysis*, Clarendon Press, oxford, 1990. 2. J.B. Conway, *Functions of one complex variables* Springer - Verlag, International student Edition, Naroser Publishing Co.1978 3. E. Hille, *Analytic function Thorey*(2 vols.), Gonm& Co, 1959. 4. M.Heins, *Complex function Theory*, Academic Press, New York,1968.
Website and e-Learning Source	http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics, http://www.opensource.org , http://en.wikipedia.org

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

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

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

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

CLO4:Develop Taylor and Laurent series .

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

	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		**PROBABILITY THEORY**					
Paper Number		**CORE IX**					
Category	Core	**Year**	II	**Credits**	5	**Course Code**	**25MATC302**
		Semester	III				
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
		5	1	--	6		
Pre-requisite		UG level algebra and calculus					
Objectives of the Course		To introduce axiomatic approach to probability theory, to study some statistical characteristics, discrete and continuous distribution functions and their properties, characteristic function and basic limit theorems of probability.					
Course Outline		**UNIT-I : Random Events and Random Variables:** Random events – Probability axioms – Combinatorial formulae – conditional probability – Bayes Theorem – Independent events – Random Variables – Distribution Function – Joint Distribution – Marginal Distribution – Conditional Distribution – Independent random variables – Functions of random variables. **Chapter 1: Sections 1.1 to 1.7** **Chapter 2 : Sections 2.1 to 2.9**					
		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**					
		UNIT-III: Characteristic functions : Properties of characteristic functions – Characteristic functions and moments – semi0invariants – characteristic function of the sum of the independent random variables – Determination of distribution function by the Characteristic function – Characteristic function of multidimensional random vectors – Probability generating functions. **Chapter 4 : Sections 4.1 to 4.7**					

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

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

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

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

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

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

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

	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		**TOPOLOGY**					
Paper Number		**CORE X**					
Category	Core	**Year**	II	**Credits**	5	**Course Code**	**25MATC303**
		Semester	III				
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
		5	1	--	6		
Pre-requisite		Real Analysis					
Objectives of the Course		To study topological spaces, continuous functions, connectedness, compactness, countability and separation axioms.					

Course Outline	**UNIT-I : Topological spaces :** Topological spaces – Basis for a topology – The order topology – The product topology on $X \times Y$ – The subspace topology – Closed sets and limit points. **Chapter 2 : Sections 12 to 17**
	UNIT-II :Continuous functions: Continuous functions – the product topology – The metric topology. **Chapter 2 : Sections 18 to 21 (Omit Section 22)**
	UNIT-III :Connectedness: Connected spaces- connected subspaces of the Real line – Components and local connectedness. **Chapter 3 : Sections 23 to 25.**
	UNIT-IV : Compactness : Compact spaces – compact subspaces of the Real line – Limit Point Compactness – Local Compactness. **Chapter 3 : Sections 26 to 29.**
	UNIT-V: Countability and Separation Axiom: The Countability Axioms – The separation Axioms – Normal spaces – The Urysohn Lemma – The Urysohnmetrization Theorem – The Tietz extension theorem. **Chapter 4 : Sections 30 to 35.**
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	James R. Munkres, *Topology* (2nd Edition) Pearson Education Pve. Ltd., Delhi-2002 (Third Indian Reprint)
Reference Books	1. J. Dugundji ,*Topology* , Prentice Hall of India, New Delhi, 1975. 2. George F.Sinmons, *Introduction to Topology and Modern Analysis*, McGraw Hill Book Co., 1963 3. J.L. Kelly, *General Topology*, Van Nostrand, Reinhold Co., New York 4. L.Steenand J.Subhash, Counter Examples in Topology, Holt, Rinehart and Winston, New York, 1970. 5. S.Willard, *General Topology*, Addison - Wesley, Mass., 1970
Website and e-Learning Source	http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics, http://www.opensource.org , http://en.wikipedia.org

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

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

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

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

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

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

	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		**FUNCTIONAL ANALYSIS**					
Paper Number		**CORE XI**					
Category	Core	**Year**	II	**Credits**	5	**Course Code**	**25MATC401**
		Semester	IV				
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
		5	1	--	6		
Pre-requisite		Elements of Real Analysis					
Objectives of the Course		To provide students with a strong foundation in functional analysis, focusing on spaces, operators and fundamental theorems. To develop student's skills and confidence in mathematical analysis and proof techniques.					
Course Outline		**UNIT-I: Banach** Spaces: The definition and some examples – Continuous linear transformations – The Hahn-Banach theorem – The natural imbedding of N in N^{**}- The open mapping theorem – The conjugate of an Operator. **Chapter 9:Sections 46-51**					

	UNIT-II: Hilbert Spaces:The definition and some simple properties–Orthogonalcomplements–Ortho normal sets–The conjugate space H^*-The adjoint of an operator–self-adjoint operators-Normal and unitary operators – Projections. **Chapter10:Sections52-59**
	UNIT-III: Finite-Dimensional Spectral Theory: Matrices – Determinants and the spectrum of an operator –The spectral theorem. **Chapter 11:Sections 60-62**
	UNIT-IV: General Preliminaries on Banach Algebras**:** The definition and some examples – Regular and singular elements – Topological divisors of zero – The spectrum – The formula for the spectral radius– The radical and semi-simplicity. **Chapter 12:Sections 64-69**
	UNIT-V: The Structure of Commutative Banach Algebras: The Gelfand mapping – Application of the formula$r(x) = \lim \|x^n\|^{1/n}$– Involutions in Banach algebras-The Gelfand-Neumark theorem. **Chapter 13:Sections 70-73**
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	G.F.Simmons,Introduction to TopologyandModernAnalysis,McGrawHillEducation(India) Private Limited, New Delhi, 1963.
Reference Books	1. W.Rudin, Functional Analysis, McGraw Hill Education (India)Private Limited, NewDelhi, 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, NewYork, 1978. 5. M. Thamban Nair, Functional Analysis, A First course, Prentice Hall of India, NewDelhi, 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

Title of the Course	**MECHANICS**					
Paper Number	**CORE XII**					
Category Core	**Year**	II	**Credits**	5	**Course Code**	**25MATC402**
	Semester	IV				

Instructional Hours per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**
	5	1	--	6

Pre-requisite	UG level Calculus and Differential equations.
Objectives of the Course	To study mechanical systems under generalized coordinate systems, virtual work, energy and momentum, to study mechanics developed by Newton, Langrange, Hamilton Jacobi and Theory of Relativity due to Einstein.
Course Outline	**UNIT-I:** Mechanical Systems: The Mechanical system- Generalised coordinates – Constraints - Virtual work - Energy and Momentum **Chapter 1 : Sections 1.1 to 1.5**
	UNIT-II: Lagrange's Equations: Derivation of Lagrange's equations- Examples- Integrals of motion. **Chapter 2 : Sections 2.1 to 2.3 (Omit Section 2.4)**
	UNIT-III: Hamilton's Equations: Hamilton's Principle - Hamilton's Equation - Other variational principle. **Chapter 4 : Sections 4.1 to 4.3 (Omit section 4.4)**

	UNIT – IV: Hamilton-Jacobi Theory: Hamilton Principle function – Hamilton-Jacobi Equation - Separability **Chapter 5 : Sections 5.1 to 5.3**
	UNIT-V: Canonical Transformation: Differential forms and generating functions – Special Transformations– Lagrange and Poisson brackets. **Chapter 6 : Sections 6.1, 6.2 and 6.3 (omit sections 6.4, 6.5 and 6.6)**
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	D. Greenwood, *Classical Dynamics*, Prentice Hall of India, New Delhi, 1985.
Reference Books	1. H. Goldstein, *Classical Mechanics,* (2nd Edition) Narosa Publishing House, New Delhi. 2. N.C.Rane and P.S.C.Joag, *Classical Mechanics*, Tata McGraw Hill, 1991. 3. J.L.Synge and B.A.Griffth, *Principles of Mechanics* (3rd Edition) McGraw Hill Book Co., New York, 1970.
Website and e-Learning Source	http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics, http://www.opensource.org, www.physicsforum.com

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO1: Demonstrate the knowledge of core principles in mechanics.

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

CLO3: Apply the variation principle for real physical situations.

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

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

	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

11.2 Project

Title of the Course		**PROJECT WITH VIVA VOCE**					
Paper Number							
Category	Core	**Year**	II	**Credits**	7	**Course Code**	**25MATP405**
		Semester	IV				
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
		7		--	7		
Pre-requisite		UG Level Mathematics					

11.3 Elective Courses

Title of the Course		**GRAPH THEORY AND APPLICATIONS**					
Paper Number		**ELECTIVE – I**					
Category	Discipline Centric Elective	**Year**	I	**Credits**	3	**Course Code**	25MATE104
		Semester	I				
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
		4	1	--	5		
Pre-requisite		UG Level Graph Theory					
Objectives of the Course		To understand and apply the fundamental concepts in Graph theory.					
Course Outline		**UNIT-I:Basic Concepts**: Graphs – Subgraphs – Degrees of vertices – Paths and connectedness – Automorphism of asimple graph, Line Graphs.Connectivity:Vertex cuts and Edge cuts – Connectivity and edge – connectivity, Blocks.					

	UNIT-II:Trees – Characterization and Simple properties-Independent sets and Matchings:Vertex Independent sets and Vertex Coverings – Edge-Independent Sets – Matchings andFactors, Matchings in Bipartite Graphs (except the proof of Tutte's 1-factor theorem).
	UNIT-III : Eulerian Graphs - Hamiltonian Graphs.
	UNIT-IV : Graph Colorings: Vertex Colorings – Critical Graphs – Brooks' Theorem.EdgeColorings of Graphs – Vizing's Theorem – Chromatic Polynomials.
	UNIT-V: Planar Graphs**:**Planar and Nonplanar Graphs – Euler's Formula and its Consequences – $K_5$and $K_{3,3}$areNonplanar graphs – Dual of a Plane Graph – The Four Color Theorem and the Heawood Five-Color Theorem – Hamiltonian plane graphs.
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	R. Balakrishnan and K. Ranganathan, A Textbook of Graph Theory(Universitext), Second Edition, Springer, New York, 2012.
Reference Books	1. J.A. Bondy and U.S.R. Murty, Graph Theory, Springer, 2008. 2. Douglas B. West, Introduction to Graph Theory, Second Edition, PHI Learning Private Ltd, New Delhi, 2011. 3. G. Chartrand, Linda Lesniak and Ping Zhang, Graphs and Digraphs, Fifth Edition, CRC Press – 2011.
Website and e-Learning Source	**https://nptel.ac.in/courses**

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO 1: Understand the basics of graph theory and their various properties.
CLO 2: Develop Models using graphs and to solve the problems algorithmically.

CLO 3: Apply graph theory concepts to solve real world applications like routing, TSP/traffic control, etc.

CLO 4: Analyse the significance of graph theory in different engineering disciplines.

CLO 5: Understand the applications of duality and planarity of graphs.

	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">DISCRETE MATHEMATICS</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">Generic 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">25MATE105</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>Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>4</td><td colspan="2">1</td><td>--</td><td colspan="2">5</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">UG level Algebra</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">To explore the knowledge in Logic and Counting, to understand relations, Digraphs and functions, to understand order relations and structures and to motivate students how to solve practical problems using Discrete Mathematics.</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="6">UNIT-I :Logic and Counting:
Propositions and logical operations, Conditional statements, Methods of Proof, Mathematical Induction. Permutations, Combinations, Pigeonhole Principle, Elements of Probability, Recurrence Relations</td></tr>
<tr><td colspan="6">UNIT-II:Relations and Digraphs:
Product sets and partitions, Relations and Digraphs, Paths in Relations and Digraphs, Properties of relations, Equivalence Relations,
Computer Representation of Relations and Digraphs, Operations on Relations, Transitive Closure and Warshall's Algorithm.</td></tr>
<tr><td colspan="6">UNIT-III :Functions:
Functions, Functions for Computer Science, Growth of Functions, Permutation Functions.</td></tr>
<tr><td colspan="6">UNIT-IV : Order Relations and Structures:
Partially Ordered Sets, Extremal Elements of Partially Ordered Sets, Lattice, Finite Boolean Algebras, Functions on Boolean Algebra, Circuit Designs.</td></tr>
<tr><td colspan="6">UNIT-V:Semigroups and Groups:
Semigroups, Product and Quotient of Semigroups, Groups, Product and Quotient of Groups.</td></tr>
</table>

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	Bernard Kolman, Robert C. Busby and Sharon Cutler Ross, Discrete Mathematical Structures, Prentice - Hall of India, New Delhi, 2002.
Reference Books	1. E.G. Goodaire and M.M. Paramenter, Discrete Mathematics with Graph Theory, Prentice Hall International Editions, New Jersey (1998). 2. J. Matonsek and J. Nesetril, Invitation to Discrete Mathematics b Clarendon Press, Oxford (1998). 3. . J.P. Tremblay and R. Manohar, Discrete Mathematical Structures wi Applications to Computer Science, Tata McGraw Hill Publication Company, 1997.
Website and e-Learning Source	**https://nptel.ac.in/courses**

Course Learning Outcome (for Mapping with POs and PSOs)

CLO 1: Understand how Logic can be used as a tool and mathematical model in the study of networks and circuits.

CLO 2: Construct mathematical arguments using logical connectives and quantifiers.

CLO 3: Apply paths in relations and Digraphs to develop the computer representation.

CLO 4: Explore Applications of Boolean Algebra

CLO 5: Learn how to work with some of the discrete structures which include semigroupsand its applications.

	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">CALCULUS OF VARIATIONS AND INTEGRAL EQUATIONS</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">ELECTIVE - III</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Generic</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">25PMATE-205</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>Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>3</td><td colspan="2">1</td><td>--</td><td colspan="2">4</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">Concepts of basic mathematics</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">Introduce the concept of calculus of variation and its applications , introduce various types of integral equations and how to solve these equations.</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="6">Unit I: Calculus of Variations and Applications:
Maxima and Minima - The Simplest case-Illustrative examples-Natural boundary conditions and transition conditions – The variational notation-The more general case.</td></tr>
<tr><td colspan="6">Unit II: Constraints and Lagrange multipliers-Variable end points - Sturm- Liouville problems-Hamilton’s principle-Lagrange’s equations.</td></tr>
<tr><td colspan="6">Unit III: Integral Equations: Introduction – Relations between differential and integral equations – The Green’s function – Alternative definition of the Green’s function.</td></tr>
<tr><td colspan="6">Unit IV: Linear equation in cause and effect: The influence function – Fredholm equations with separable kernels – Illustrative example.</td></tr>
<tr><td colspan="6">Unit V: Hilbert – Schmidt theory – Iterative methods for solving equations of the second kind – Fredholm theory.</td></tr>
<tr><td colspan="2">Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)</td><td colspan="6">Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved
(To be discussed during the Tutorial hour)</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 Transferrable Skill</td></tr>
<tr><td colspan="2">Recommended Text</td><td colspan="6">Francis B. Hildebrand, Methods of Applied Mathematics, (Second Edition) Prentice Hall of India Pte. Ltd., New Delhi. 1968.</td></tr>
</table>

Reference Books	1. L. Elsgolts, Differential Equations and the Calculus of Variations Mir Publishers,Moscow, 1973. 2. Ram P. Kanwal, Linear Integral Equations. Academic Press, New York, 1971. 3.I.N.Snedden, Mixed Boundary Value Problems in Potential Theory, North Holland, 1966. 4. Integral Equations and their Applications, M.Rahman WIT Press, Boston, 2007.
Website and e-Learning Source	1. http://www.maths.ed.ac.uk/~jmf/Teaching/Lectures/CoV.pdf 2. https://archive.nptel.ac.in/courses/111/104/111104025/

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO1 -Students know the concept and properties of variational problems with fixed and moving boundaries, functions of dependent and independent variables and also solve some applications problems in mechanics.
CLO2 - Able to solve differential equations and integral equation problems. Find the solution of eigen value, eigen functions.
CLO3 -Implementation of various methods to solve FredholmIntergral equation.
CLO4 -Students gain acquire knowledge about Hilbert – Schmidt Theory
CLO5 -Deriving the complex Hilbert space – Orthogonal system of function and Solutions of Fredholm of Integral equation of first kind

	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		**STOCHASTIC PROCESSES**						
Paper Number		**ELECTIVE - IV**						
Category	Discipline Centric	**Year**	II	**Credits**	3	**Course Code**	**25MATE304**	
		Semester	III					
Instructional Hours per week		**Lecture**	**Tutorial**		**Lab Practice**		**Total**	
		4	1		--		5	
Pre-requisite		Concepts of basic mathematics						

Objectives of the Course	Acquire the skill of advanced level of mathematical sophistication and enhancing the horizons of knowledge, understanding of applicability of different concepts of stochastic processes, use of stochastic models in different areas.
Course Outline	**UNIT – I :Stochastic Processes:** Introduction, Specification of Stochastic Processes, Stationary Process, Martingales. Markov Chains: Definition and Examples, Higher Transition Probabilities, Generalization of independent Bernoulli Trials: Sequence of Chain Dependent Trials, Classification of States and Chains.
	UNIT – II :More on Markov Chains: Determination of Higher Transition Probabilities, Stability of a Markov System, Markov Chain with Denumerable Number of States, Reducible Chains.
	UNIT – III :Markov Processes with Discrete State Space: Poisson Process and its Extensions: Poisson Process, Poisson Process and Related Distributions, Generalization of Poisson Process, Birth and Death Process, Markov Process with Discrete State Space (Continuous Time Markov Chains).
	UNIT – IV :Markov Chains and Markov Processes with Continuous State Space: Markov Chains with Continuous State Space, Introduction, Brownian Motion, Wiener Process, Differential Equations for a Wiener Process, Kolmogorov Equations, First Passage Time Distribution for Wiener Process.
	UNIT – V :Renewal Processes and Theory: Renewal Process, Renewal Processes in Continuous Time, Renewal Equation, Stopping time: Wald's Equation, Renewal Theorems, Delayed and Equilibrium Renewal Processes.
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	J. Medhi, Stochastic Processes, Wiley Eastern Limited, New Delhi, (Second Edition), 1994.
Reference Books	1. S. Karlin and H.M. Taylor, A First Course in Stochastic Processes, Academic Press (second edition), New York, 2011. 2. S.M. Ross, Stochastic Processes,Wiley India Pvt., Ltd.,2nd Edition, 2008.
Website and e-Learning Source	**https://nptel.ac.in/courses**

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO 1-Understand the concept of Stochastic Processes

CLO 2-Understand the concept of Markov Chains.

CLO 3-Understand the concept of Markov Processes with Discrete State Space

CLO 4-Understand the concept of Markov Chains and Markov Processes with Continuous State Space.

CLO 5- Know the Renewal Processes in Continuous Time, Renewal Equation, Equilibrium Renewal processes.

	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">MATHEMATICAL STATISTICS</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">Discipline Centric 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">25MATE403</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>Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>3</td><td colspan="2">1</td><td>--</td><td colspan="2">4</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6"></td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">1. To study random variables and its applications.
2. To explore probability distributions.
3. To understand moments and their functions.
4. To introduce significance tests.
5. Concepts of ANOVA</td></tr>
<tr><td colspan="2" rowspan="2">Course Outline</td><td colspan="6">UNIT-I :Definition, scope, functions and limitations of Statistics – Collection, Classification, Tabulation of data, Diagrammatic representation of data – Simple, Multiple and Percentage Bar diagram, Pie diagram and Graphical representation of data – Histogram, frequency polygon, frequency curve and ogives. Primary and Secondary data – Questionnaire method.</td></tr>
<tr><td colspan="6">UNIT-II:Measures of Central tendency – Mean, Median and Mode and their practical usages. Measures of Dispersion: Range, Quartile Deviation, Mean Deviation, Standard Deviation, Variance and Coefficient of Variation. Measures of Skewness – Pearson’s, Bowley’s method. Applications of Binomial and Normal distributions.</td></tr>
</table>

	UNIT-III : Measure of Bivariate data – Simple, Partial and Multiple Correlation. Scatter diagram, Pearsons method and Rank correlation method. Regression and their equations – Prediction. Basic concept of Sampling – Parameter and Statistics – Sampling distribution and Standard Error – Simple random sampling and stratified random sampling.
	UNIT-IV : Tests of Significance with their important concepts. Tests for large samples - Test for mean, difference of means, proportion and equality of proportions. Small sample tests – Test for mean, difference of Means, paired samples, test for correlation and regression coefficients.
	UNIT-V: Chi square test for goodness of fit and independence of attributes. F-test – Analysis of variance, Assumptions, Applications, one way anova and two way anova classifications. Note: The emphasis is only on the application of the methods. The derivations of the formulae are not necessary.
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	Gupta, S.P, Statistical Methods, Sultan Chand & Sons, Pvt. Ltd, New Delhi – 2011
Reference Books	1. Gupta, S.C and V.K. Kapoor, (2011) Fundamentals of Mathematical Statistics Chand & Sons, Pvt. Ltd, New Delhi 2. V.K.Rohatgi, An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern New Delhi, 1988(3rd Edn).
Website and e-Learning Source	**https://nptel.ac.in/courses**

Course Learning Outcome (for Mapping with POs and PSOs)

After completion of this course the student will be able to

CLO 1: Apply the concepts of random variables in real life situations.
CLO 2: Identify the type of statistical situation to which different distributions can be applied.
CLO 3: Calculate moments and their functions.
CLO 4: Explore knowledge in the various significance tests for statistical data.
CLO 5: Analyze statistical data using ANOVA.

	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

11.4 Industry Oriented Course/Entrepreneurship Oriented Course

Title of the Course		**OPTIMIZATION TECHNIQUES**					
Paper Number		**ELECTIVE – VI**					
Category	Discipline Centric	**Year**	II	**Credits**	3	**Course Code**	**25MATE404**
		Semester	IV				
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
		3	1	--	4		
Pre-requisite		Concepts of basic mathematics					
Objectives of the Course		Acquire the skill of advanced level of mathematical sophistication and enhancing the horizons of knowledge, understanding of applicability of different concepts of operations research.					
Course Outline		**Unit I:** The General Linear- Programming Problem: The linear Programming Problem-Properties of a solution to the Linear Programming Problem- Generating Extreme- Point solutions. The Simplex Computational Procedure: Development of a minimum feasible solution- Computational Procedure. **Chapter 3: Section 3.1 to 3.3**					
		UNIT – II : The Artificial- Basis Technique- A First feasible solution using slack variables- Geometric Interpretation of the Simplex Procedure. Degeneracy Problems: Perturbation Techniques- Example of Cycling. **Chapter 4: Section 4.1 and 4.2**					
		UNIT – III : The Duality problems of Linear Programming: The unsymmetric Primal- Dual Problems- The Symmetric Primal- Dual Problems, Economic Intrepretation of the Primal- Dual Problems. **Chapter 4: Section 4.3 to 4.5**					

	UNIT – IV : Additional Computational Techniques: Determining a first feasible solution- The Dual Simplex Method- Integer Programming. The Transportation Problem: The General Transportation Problem- Variations of the Transportation Problem- Variations of the Transportation Problem. **Chapter 6, Chapter 7 : Section 7.1 to 7.3**
	UNIT – V : Game Theory: Optimal Solution of Two Person Zero-Sum Games, Mixed Strategies, Graphical Solution of $2LL$ and $L\ L2$ Games, Solution of $(L\ \times L)$ Games by Linear Programming. **Chapter 9: Section 9.1 to 9.3** **Chapter 10 :Section 10.1 to 10.3.**
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	1. Saul I. Gass, Linear Programming., Mc Graw-Hill Book Company, (fifth Edition), 1985. 2. Hamdy A. Taha,,Operations Research: An introduction . PHI Pvt. LTD., (Sixth Edition) 1998. Chapter 14 Section 14.5 Only.
Reference Books	1. 'Operations Research' by Kanti Swarup, P.K. Gupta and Man Mohan, Sultan Chand and Sons, Delhi, 1985. 2. 'Mathematical Programming' by N.S.Kambo, Affiliated East-West Press, New Delhi, 1991. 3. 'Introduction to the Theory of Games' by J. Mikinsy, Mc Graw Hill, New York, 1963.
Website and e-Learning Source	**https://nptel.ac.in/courses**

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO 1-Understand the concept of Linear programming problem
CLO 2-Understand the concept of Transportation problem
CLO 3-Understand the concept of Game theory

	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

11.5 Skill Enhancement Courses

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">MATHEMATICAL DOCUMENTATION USING LaTeX</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">SKILL ENHANCEMENT COURSE-1</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Skill Enhancement</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">25MATS206</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>Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>2</td><td colspan="2">-</td><td>2</td><td colspan="2">4</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">Basic type set concept</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">• Introduction of the Software knowledge in LaTeX,
• Knowing the importance of this software for publishing research articles, papers, project reports and books,
• Mathematics structures using LaTeX,
• Capable to create a tables and figures in LaTeX,
• Understanding the concept of beamer to create presentation.
.</td></tr>
<tr><td colspan="2" rowspan="2">Course Outline</td><td colspan="6">Unit I: Introduction
Introduction – TEX and its offspring - Basics of a LATEX file – TEX processing procedure – Text, Symbols, and Commands – Command names and arguments – Environments – Declarations – Lengths – Special characters– Document Layout and Organization – Document class – Page style – Parts of the document – Table of contents
Chapter – 1, 2 and 3</td></tr>
<tr><td colspan="6">Unit II: Displayed Text
Changing font – Centering and indenting – Lists – Generalized lists – Theorem-like declarations – Tabulator stops – Boxes – Tables – Printing literal text – Footnotes and marginal notes – Comments within text
Chapter – 4</td></tr>
</table>

	UNIT III: Mathematical Formulas Mathematical environments – Main elements of math mode – Mathematical symbols – Additional elements – Fine-tuning mathematics – Beyond standard LaTeX Error message, tex error message, warning. **Chapter – 5 and Appendix C**
	UNIT IV: Graphics, Tables and Figures The graphics packages – Adding color – Float placement – Postponing floats–Style parameters for floats –Float captions – Float examples – References to figures and tables in text – Some float packages **Chapter – 6 and 7**
	UNIT V: Bibliographic Databases &Presentation The BIBTEX program – Creating a bibliographic database – Customizing bibliography styles – Slide production with SLITEX – Slide production with seminar – Electronic documents for screen viewing – Special effects with PDF **Chapter – 14 and 15**
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Typing of Mathematical materials (To be practiced in the practical hours)
Skills acquired from this course	On completing this syllabus, Learners will be able to • Remember to Download and install open source software Latex, • Understanding and formatting Latex, • Typeset mathematical formulas, use nested list, tabular & array environments, • Create or import graphics, • Use beamer to create presentation.

Recommended Text	**A Guide to LaTeX and Electronic Publishing (4th Edition) – Helmut Kopkaand Patrick W. Daly**, Addison Wesley Longman Limited, England, 2004. .
Reference Books	1. **LaTeX in 24 Hours – A Practical Guide for Scientific Writing**, **DilipDatta**, Springer International, 2017. 2. **Digital Typography Using LaTeX,** ApostolosSyropoulosAntonisTsolomitis and Nick Sofroniou, Springer International, 2003. 3. **Practical LaTeX, George Gratzer,** Springer International, 2014.
Website and e-Learning Source	**https://nptel.ac.in/courses**

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO 1-Understand the concept of formatting latex.
CLO 2-Understand the concept of Mathematical format.
CLO 3-Understand the concept of Graphics.

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

Title of the Course		**PROGRAMMING IN C++ WITH PRACTICAL**					
Paper Number		**SKILL ENHANCEMENT COURSE-II**					
Category	Skill Enhancement	**Year**	II	**Credits**	2	**Course Code**	**25MATS305**
		Semester	III				
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
		2	-	1	3		
Pre-requisite							

Objectives of the Course	• To introduce the basics of object oriented programming and to give detailed branching and looping structure in C++. • To master in creating and handling classes and class functions. To provide fair confident on working with pointers and files in C++. • To make students to write C++ programs with their own algorithm to solve the given any simple problems.
Course Outline	**Unit I** Tokens, Expressions and Control structures- Functions on C++.
	Unit II Classes and Objects.
	Unit III Constructors and Destructors- Operator overloading and type conversions.
	Unit IV Inheritance: Extending classes- Pointers, \virtual Functions and Polymorphism.
	Unit V Working with files
	List of Practical's: 1. Programs to evaluate sin X, cos X, L^{LL} to 0.00001% accuracy. 2. Program to calculate the variance and standard deviation of a set of numbers. 3. Program to find product of matrices, inverse of a matrix using functions. Macro that obtains largest of three numbers. 4. Define a class of students and prepare a statement containing name, total marks of Ranks (using functions). 5. Program to check whether a number/ string is a palindrome without using the corresponding standard function. 6. Define a class string and exhibit the use of string manipulations. 7. Create a class FLOAT that contains one float data. Overload all the four arithmetic. 8. Write a C++ program implement a class 'Complex' of complex numbers. The class should be include member functions to add and subtract two complex numbers. 9. Write a C++ program implement a class for complex numbers with add and multiply as member functions. Overload ++ operator to increment a complex number. 10. Write a program in C++ to demonstrate friend function.

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Problem Solving and Professional Competency in Coding.
Skills acquired from this course	Knowledge and Transferrable Skill .
Recommended Text	E. Balagurusamy, Objected Oriented Programming with C++, (Third Edition), (2007), Tata Mc Graw Hill, Unit I to V: Chapters 3 to 9 and 11.
Reference Books	1. H. Schildt, C++: The Complete References(4th Ed.), McGraw Hill, 2017 2. Yashavant Kanetkar, Let us C++, BpB Publications, 2020
Website and e-Learning Source	https://nptel.ac.in/courses/106/105/106105151/

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO 1- Writing C++ Coding.
CLO 2- Solving Problems

	POs						PSOs		
	1	2	3	4	5	6	1	2	3
CLO1	3	1	1	2	3	1	3	2	1
CLO2	1	2	3	1	1	1	3	2	1

11.6 Skill Enhancement Course/Professional Competency Skill

Title of the Course		**MATHEMATICS FOR ADVANCED RESEARCH STUDIES**					
Paper Number		**SKILL ENHANCEMENT COURSES/PROFESSIONAL COMPETENCY SKILL**					
Category	Skill Enhancement	**Year**	II	**Credits**	2	**Course Code**	**25MATS405**
		Semester	IV				
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
		2	-	2	4		
Pre-requisite		UG level real analysis					
Objectives of the Course		To explore the knowledge in various mathematical techniques and to solve problems using the techniques.					

Course Outline	**Unit-I:** Laplace Transform Definition, Transform of some elementary functions, rules of manipulation of Laplace Transform, Transform of Derivatives, relation involving Integrals, the error function, Laplace transform of Bessel functions, Periodic functions, convolution of two functions
	Unit II : Inverse Laplace Transform, Tauberian Theorems, Ordinary differential equations- Initial value problems for linear equations with constant coefficients, two-point boundary value problem for a linear equation with constant coefficients, linear differential equation with variable coefficients, simultaneous differential equations with constant coefficients, Solution of diffusion and wave equation in one dimension and Laplace equation in two dimensions.
	Unit-III: Fourier Transform Fourier integral Theorem, Fourier Transform, Fourier Cosine Transform, Fourier Sine Transform, Transforms of Derivatives, Fourier transforms of simple Functions, Fourier transforms of Rational Functions.
	Unit IV: Convolution 3 Integral, Parseval's Theorem for Cosine and Sine Transforms, Inversion Theorem, Solution of Partial Differential Equations by means of Fourier Transforms. First order and second order Laplace and Diffusion equations
	Unit-V: Hankel Transform Elementary properties, Inversion theorem, transform of derivatives of functions, transform of elementary functions, Parseval relation, relation between Fourier and Hankel transform, use of Hankel Transform in the solution of Partial differential equations, Dual integral equations and mixed boundary value problems
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics from various Competitive Examinations UPSC/TRB/UGC-NET/TNPSC others to be solved.
Skills acquired from this course	Knowledge, Problem solving and Transferrable skill
Recommended Text	Content and Treatment as in the books Unit-I to V: Ian N. Sneddon , "The Use of Integral Transforms" McGraw Hill; Second Printing edition,1972.
Reference Books	1. Ian N. Sneddon, Fourier Transforms, Dover Publications, 2010.
Website and e-Learning Source	http://mathforum.org

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO 1- Understand the concept of mathematical transforms
CLO 2- Understand the concept of solving problems
CLO 3- Understand the concept of Applications of the techniques.

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

11.7 Internship/Industrial Activity/Industrial activity Course

Title of the Course		**INTRODUCTION TO MATLAB**					
Paper Number		**SKILL ENHANCEMENT COURSES/PROFESSIONAL COMPETENCY SKILL**					
Category	Skill Enhancement	**Year**	II	**Credits**	2	**Course Code**	**25MATI306**
		Semester	IV				
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
		2	-	2	4		
Pre-requisite							
Objectives of the Course		• MATLAB was primarily designed to do numerical calculations and computer algebra systems were failed to do. By learning the software packages along with some exercises will be built up some knowledge in this course, • The basic building block of MATLAB is the matrix. Vectors, scalars, real matrices, and complex matrices are special cases of basic data types. The built-in functions used to optimize the vector operations. Consequently, it runs commands or codes much faster in MATLAB, • Most of the script and functions use state-of-the-art algorithms. Since they allow the learners to reuse sequences of commands by storing them in code files, • To provide an overview to program curve fitting & solve Linear and Nonlinear Equations, • The 2D and 3D plot function enable us to create a graphical representation of the data for the considered problem. •					
Course Outline		**Unit-I:** Introduction – Basics of MATLAB, Input-Output, File types – Platform dependence – General commands.					

	Unit-II : Interactive computation: Matrices and vectors – Matrix and array operations – Creating and using Inline functions– Using Built in functions and Online help – Saving and loading data – Plotting simple graphs.
	Unit-III : Programming in MATLAB: Scripts and functions – Script files – Function files – Language specific features – Advanced data objects
	Unit-IV : Applications – Linear Algebra – Curve fitting and interpolation – Data analysis and statistics – Numerical integration – Ordinary differential equations – Nonlinear algebraic equations.
	Unit-V : Graphics: Basics 2D plots – Using subplot to layout multiple graphs – 3D plots – Handle graphics – Saving and printing graphics – Errors – Some applications functions – Data analysis & Fourier transforms – Polynomials and data interpretation - Nonlinear numerical methods.
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	To acquire Knowledge and Problem solving using MATLAB
Skills acquired from this course	Knowledge, Problem solving skills and Graphical application
Recommended Text	**Text Book:** Holly Moore , MATLAB for Engineers, , Pearson/Prentice Hall (2007) ISBN:013-187244-3
Reference Books	Rudra Pratap. (2010). Getting Started with MATLAB – A Quick Introduction for Scientists and Engineers. Oxford University Press. William John. P. (2005). Introduction to Matlab 7 for Engineers. Mc Graw-Hill Professional. Dolores Etter, M., David C. Kuncicky, (2004). Introduction to Matlab 7. Prentice Hall. Stephen J. Chapman, (1999). Matlab Programming for Engineers. (4th ed.). Cl Engineering. Edward Magrab, B. Balakumar, B. Duncan, J. Walsh, G. Azarm, S., Keith E. Herold, (2000). An Engineers Guide to Matlab. (3rd ed.). Pearson.
Website and e-Learning Source	https://in.mathworks.com/solutions/control-systems/resources.html https://itservices.usc.edu/matlab/resources/ https://matlabacademy.mathworks.com/

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO 1- Understand the format of MATLAB
CLO 2- Understand the application of MATLAB
CLO 3- Understand the solution of Mathematical Problems

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