APPENDIX – CM

MADURAI KAMARAJ UNIVERSITY

(University with Potential for excellence)

M.Sc., Mathematics (Semester)

CHOICE BASED CREDIT SYSTEM REGULATIONS AND SYLLABUS

(This will come into effect from the academic year 2023 onwards)

CONTENTS

1. **Preamble**
2. **Structure of Course**
3. **Learning and Teaching Activities**
4. **Tutorial Activities**
5. **Laboratory Activities**
6. **Field Study Activities**
7. **Assessment Activities**
   - **7.1 Assessment principles**
   - **7.2 Assessment Details**
8. **Teaching methodologies**
9. **Faculty Course File**
10. **Template for PG Programme in Mathematics**
11. **Template for Semester**
12. **Instructions for Course Transaction**
13. **Testing Pattern**
14. **Different Types of Courses**
15. **Elective Courses (ED from other Department Experts)**
16. **Skill Development Courses**
17. **Institution-Industry-Interaction**
18. **Model Syllabus**

1. Preamble

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

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

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 students skills.
Three domains:

(i)Cognitive Domain

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

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

(ii) Affective Domain

(iii) Psychomotor Domain

2 Post Graduate Programme

Eligibility for Admission:

A candidate with a pass in B.Sc., Mathematics degree or other degree accepted by Madurai Kamaraj University as equivalent to B. Sc., Mathematics is eligible to join the course.

Duration of the Programme : 2 years

Medium of Instructions : English

TANSCHE REGULATIONS ON LEARNING OUTCOMES-BASED CURRICULUM FRAMEWORK FOR POSTGRADUATE EDUCATION	
Programme	**M.Sc., Mathematics**
Programme Code	
Duration	**PG - 2 years**
Programme Outcomes (Pos)	**PO1: Problem Solving Skill** Apply knowledge of Management theories and Human Resource practices to solve business problems through research in Global context. **PO2: Decision Making Skill** Foster analytical and critical thinking abilities for data-based decision-making. **PO3: Ethical Value** Ability to incorporate quality, ethical and legal value-based perspectives to all organizational activities. **PO4: Communication Skill** Ability to develop communication, managerial and interpersonal skills. **PO5: Individual and Team Leadership Skill** Capability to lead themselves and the team to achieve organizational goals. **PO6: Employability Skill** Inculcate contemporary business practices to enhance employability skills in the competitive environment.

	PO7: Entrepreneurial Skill Equip with skills and competencies to become an entrepreneur. **PO8: Contribution to Society** Succeed in career endeavours and contribute significantly to society. **PO 9 Multicultural competence** Possess knowledge of the values and beliefs of multiple cultures and a global perspective. **PO 10: Moral and ethical awareness/reasoning** Ability to embrace moral/ethical values in conducting one's life.
Programme Specific Outcomes (PSOs)	**PSO1 – Placement** To prepare the students who will demonstrate respectful engagement with others' ideas, behaviours, beliefs and apply diverse frames of reference to decisions and actions. **PSO 2 - Entrepreneur** To create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate startups and high potential organizations. **PSO3 – Research and Development** Design and implement HR systems and practices grounded in research that comply with employment laws, leading the organization towards growth and development. **PSO4 – Contribution to Business World** To produce employable, ethical and innovative professionals to sustain in the dynamic business world. **PSO 5 – Contribution to the Society** To contribute to the development of the society by collaborating with stakeholders for mutual benefit.

Credit Distribution for PG Programme

Semester–I	Credit	Semester-II	Credit	Semester-III	Credit	Semester–IV	Credit
1.1. Core-I	4	2.1. Core-IV	4	3.1. Core-VII	4	4.1. Core-X	4
1.2 Core-II	4	2.2 Core-V	4	3.2 Core-VII	4	4.2 Core-XI	4
1.3 Core – III	4	2.3 Core – VI	4	3.3 Core – IX	4	4.3 Core – XII	4
1.4 Elective (Generic / Discipline Centric)- I	3	2.4 Elective (Generic / Discipline Centric) – III	3	3.4 Elective (Generic / Discipline Centric) – V	3	4.4 Elective (Generic / Discipline Centric) – VI	3
1.5 Elective (Generic / Discipline Centric)-II	3	2.5 Elective (Generic / Discipline Centric)-IV	3	3.5 Core Industry Module	3	4.5 Project with Viva-Voce	3
1.6Ability Enhancement Course- Soft Skill -1	2	2.6 Ability Enhancement Course - Soft Skill -2	2	3.6 Ability Enhancement Course- Soft Skill -3	2	4.6 Ability Enhancement Course- Soft Skill -4	2
Skill Enhancement Course SEC 1	2	2.7 Skill Enhancement Course SEC 2	2	3.7 Skill Enhancement Course – Term Paper and Seminar Presentation SEC 3	2	4.7 Skill Enhancement Course - Professional Competency Skill	2
				3.8 Internship/ Industrial Activity	2	4.8 Extension Activity	1
	22		**22**		**24**		**23**
						Total Credit Points	**91**

Core- Papers **12 x 4 = 48**

Elective (Generic / Discipline Centric) **8 x 3 = 24**

Ability Enhancement Course- Soft Skill - **8 x 2 = 16**

Internship/ Industrial Activity **1 x 2 = 2**

Extension Activity **1 x 1 = 1**

Total Credits **91**

ComponentwiseCreditDistribution

Credits	SemI	SemII	SemIII	SemIV	Total
PartA	18	18	18	18	72
Part B (i)Discipline– Centric/GenericSkill	2	2	2	2	8
(ii)SoftSkill	2	2	2	2	10
(iii)SummerInternship/Industrial Training			2		
PartC				1	1
Total	22	22	24	23	91

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

M.Sc., Mathematics

Programme Specific Outcomes:

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

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

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

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 b. Structure of Course

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

internal component only, Not to be included in the External Examination question paper)	TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)	
Skills acquired from the course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill	
Learning Resources: • **Recommended Texts** • **Reference Books** • **Web resources**		
Board of Studies Date:		

3. Learning and Teaching Activities

3.1 Topic wise Delivery method

Hour Count	Topic	Unit	Mode of Delivery

3.2 Work Load

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

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

1. **Tutorial Activities**

Tutorial Count	Topic

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

Assessment Principles:

Assessment for this course is based on the following principles

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

Assessment Details:

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

CONTENTS

a. Academic Schedule
b. Students Name List
c. Time Table

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

Credit Distribution for PG Programme in Mathematics

M.Sc Mathematics

First Year

Semester-I

	Courses	**Credit**	**Hours per Week(L/T/P)**
PartA	Core Courses3 (CC1, CC2, CC3)	12	15
	Elective Courses 2(Generic / Discipline Specific)EC1, EC2	6	10
Part B	Skill Enhancement Course -SEC 1 (One from Group G)	2	3
	Ability Enhancement Compulsory Course(AECC 1) Soft Skill-1	2	2
		22	**30**

Semester-II

	Courses	**Credit**	**Hours per Week(L/T/P)**
PartA	Core Courses3 (CC4, CC5, CC6)	12	15
	Elective Course 2(Generic / Discipline Specific) EC3, EC4	6	10
PartB	Skill Enhancement Course -SEC 2 (One from Group G)	2	3
	Ability Enhancement Compulsory Course(AECC 2) Soft Skill-2	2	2
		22	**30**

Second Year -Semester-III

	Courses	**Credit**	**Hours per Week(L/T/P)**
PartA	Core Courses3 (CC7, CC8, CC9)	12	15
	Elective Course 1 (Generic / Discipline Specific)EC5	3	5
	Core Industry Module	3	4
PartB	Skill Enhancement Course -SEC 3 Professional Communication Skill (Term Paper & Seminar Presentation)	2	4
	Ability Enhancement Compulsory Course(AECC 3) Soft Skill-3	2	2
	Internship / Industrial Activity (Carried out in Summer Vacation at the end of I year – 30 hours)	2	
		24	**30**

Semester-IV

Part	Courses	Credit	Hours per Week(L/T/P)
PartA	Core Courses3 (CC10, CC11, CC12)	12	15
	Elective Course 1 (Generic / Discipline Specific) EC6	3	5
	Project with Viva voce (CC13)	3	4
Part B	Professional Competency Skill Enhancement Course: – 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
	Ability Enhancement Compulsory Course(AECC 4) Soft Skill-4	2	2
Part C	Extension Activity (Can be carried out from Sem II to Sem IV)	1	
		23	**30**

Credit Distribution for PG Programme in Mathematics

M.Sc Mathematics

Illustration – I

	First Year Semester-I	Credit	Hours per week(L/T/P)
Part A	CC1 - Algebraic Structures	4	5(4L + 1T)
	CC2 - Real Analysis I	4	5(4L + 1T)
	CC3 - Ordinary Differential Equations	4	5(4L + 1T)
	Elective I(Generic / Discipline Specific)(One from GroupA) Number theory and Cryptography	3	5(4L + 1T)
	Elective II(Generic / Discipline Specific)(One from Group B) Mathematical Programming	3	5(4L + 1T)

Part B	Ability Enhancement Compulsory Course(AECC 1) Soft Skill-1	2	2
	Skill Enhancement Course -SEC 1 (One from Group G)	2	3
	Total	**22**	**30**

	Semester-II	**Credit**	**Hours per week(L/T/P)**
Part A	CC4 – Advanced Algebra	4	5(4L + 1T)
	CC5 – Real Analysis II	4	5(4L + 1T)
	CC6 - Partial Differential Equations	4	5(4L + 1T)
	ElectiveIII (Generic / Discipline Specific)(One from Group C) Mathematical Statistics	3	5(4L + 1T)
	Elective-IV(Computer / IT related) (One from Group D) Modelling and Simulation with Excel	3	5 (3L+ 2 P)
Part B	Skill Enhancement Course -SEC 2 (One from Group G)	2	3
	Ability Enhancement Compulsory Course(AECC 2) Soft Skill-2	2	2
	Total	**22**	**30**

	Second Year - Semester-III	**Credit**	**Hours per week(L/T/P)**
Part A	CC7 - Complex Analysis	4	5(4L + 1T)
	CC8 - Probability Theory	4	5(4L + 1T)
	CC9 – Topology	4	5(4L + 1T)
	Elective V(Generic / Discipline Specific)(One from Group E) Mathematical Python	3	5(4L + 1T)
	CC10-Core Industry Module	3	5(4L + 1T)
Part B	Internship / Industrial Activity (Carried out in Summer Vacation at the end of I year – 30 hours)	2	
	Skill Enhancement Course -SEC 3 :Professional Communication Skill -Term paper & Seminar presentation	2	3
	Ability Enhancement Compulsory Course(AECC 3) Soft Skill-3	2	2
	Total	**24**	**30**

	Semester-IV	**Credit**	**Hours per week(L/T/P)**
Part A	CC11–Functional Analysis	4	5(4L + 1T)
	CC12 - Differential Geometry	4	5(4L + 1T)
	CC13 - Mechanics	4	5(4L + 1T)
	Elective VI(Generic / Discipline Specific)(One from Group F) Resource Management Techniques	3	5(4L + 1T)
	CC14 - Core Project with viva voce	3	4
Part B	Professional Competency Skill Enhancement Course 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) ORMathematics for Advanced Research Studies (4 hours)	2	4
	Ability Enhancement Compulsory Course(AECC 4) Soft Skill-4	2	2
Part C	Extension Activity	1	
	Total	**23**	**30**

TOTAL CREDITS: 91

Consolidated Table for Credits Distribution

	Category of Courses	Credits for each Course	Number of Courses	Number of Credits in each Category of Courses	Total Credits	Total Credits for the Programme
PART A	Core	4	12	48	72	80 (CGPA)
	Project with viva voce	3	1	3		
	Industry aligned Programmes-	3	1	3		
	Elective (Generic and Discipline Centric)	3	6	18		
PART B (i)	Skill Enhancement (Term paper and Seminar &Generic / Discipline - Centric Skill Courses) (Internal Assessment Only)	2	4	8	8	
PART B (ii)	Ability Enhancement (Soft skill)	2	4	8	10	11 (Non CGPA)
(iii)	Summer Internship	1	2	2		
PART C	Extension Activity	1	1	1	1	
						91

Template for Semester

Code	Category	Title of the Paper	Marks (Max 100)		Duration for UE	Credits
			CIA	UE		
Semester –I						
Part A	Core I		25	75	3 Hrs	4
	Core II		25	75	3 Hrs	4
	Core III		25	75	3 Hrs	4
	Elective I	Elective-I (Choose one from Group-A)	25	75	3 Hrs	3
	Elective II	Elective-I I (Choose one from Group-B)	25	75	3 Hrs	3
Part B	Skill Enhancement Course -SEC 1	(Choose One from group G)	Internal Assessment			2
	Ability Enhancement Course(AECC1)	Soft Skill I	Performance based assessment			2
Semester-II						
Part A	Core IV		25	75	3 Hrs	4
	Core V		25	75	3 Hrs	4
	Core VI		25	75	3 Hrs	4
	Elective III	Elective-III (Choose one from Group-C)	25	75	3 Hrs	3
	Elective IV	Elective-IV (Choose one from Group-D)	25	75	3 Hrs	3
Part B	Skill Enhancement Course -SEC 2	(Choose one from Group-G)	Internal Assessment			2
	Ability Enhancement Course(AECC 2)	Soft Skill II	Performance based assessment			2

Semester-III						
Part A	Core VII		25	75	3 Hrs	4
	Core VIII		25	75	3 Hrs	4
	Core IX		25	75	3 Hrs	4
	Elective / ED V	Elective-VI /ED-V (Choose one from Group-E)	25	75	3 Hrs	3
	Core Industry Module	ED-IV (Choose from outside the Department)	25	75	3 Hrs	3
Part B						
	Skill based (Term paper and Seminar)	Assignment of problem by the faculty Lecture -I (by the student) 25% Lecture-II (by the student) 25% Lecture-III (by the student) 25% Submission of a write-up (10-15 pages using LaTeX) 25% Marks / Grade Point/ Letter Grade as per the Regulation)				2
	Ability Enhancement Course(AECC 3)	Soft Skill III	Performance based assessment			2
	Internship / Industrial - Vacation Activity					2
Semester-IV						
Part A	Core X		25	75	3 Hrs	4
	Core XI		25	75	3 Hrs	4
	Core XII		25	75	3 Hrs	4
	Project with viva voce XIII		25	75	3 Hrs	3
	Elective VI	Elective-VI (Choose one from Group – F)	25	75	3 Hrs	3
Part B	Skill Enhancement Course -SEC 4	Professional Competency Skill Enhancement Course	Internal Assessment			2
	Ability Enhancement Course(AECC4)	Soft Skill IV	Performance based assessment			2
Part C	Extension Activity	Performance based assessment				1
					Total Credits	**91**

Elective Courses

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

Semester I : Elective I and Elective II

Elective I to be chosen from Group A and **Elective II** to be chosen from Group B

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

1. Number Theory and Cryptography
2. Graph Theory and Applications
3. Formal Languages and Automata Theory
4. Programming in C++ and Numerical Methods

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

1. Lie Groups and Lie Algebras
2. Mathematical Programming
3. Fuzzy Sets and Their Applications
4. Discrete Mathematics

Semester II : Elective III & Elective IV

Elective III to be chosen from **Group C** and **Elective IV** to be chosen from **Group D**

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

1. Algebraic Topology
2. Mathematical Statistics
3. Statistical Data Analysis using R Programming
4. Tensor Analysis and Relativity

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

1. Wavelets
2. Modeling and Simulation with Excel
3. Machine Learning and Artificial Intelligence
4. Neural Networks

Semester III : Elective V

Elective V to be chosen from Group E.

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

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

Semester IV : Elective VI

Elective VI to be chosen from Group F.

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

1. Algebraic Geometry
2. Financial Mathematics
3. Resource Management Techniques
4. Mathematical Python

Skill Enhancement Courses

Skill Enhancement Courses are chosen so as to keep in pace with the latest developments in the academic / industrial front and provides flexibility of choice by the stakeholders / institutions.

Group G (Skill Enhancement Courses) SEC:

- Computational Mathematics using SageMath
- Mathematical documentation using LATEX / other packages
- Office Automation and ICT Tools
- Numerical analysis using SCILAB
- Differential equations using SCILAB
- Industrial Mathematics /Statistics using latest programming packages
- Research Tools and Techniques

Ability Enhancement Courses

- Soft Skill courses

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: Mathematics for Life Sciences

ED-II: Mathematics for Social Sciences

ED-III: Statistics for Life and Social Sciences

Instructions for Course Transaction

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

Testing Pattern (25+75)

Internal Assessment

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

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

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

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

Question paper Model

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

Each question should carry the course outcome and cognitive level

For instance,

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

Different Types of Courses

(i) CoreCourses (Illustrative)

1. Algebra
2. Real Analysis
3. Ordinary Differential Equations
4. Partial Differential Equations
5. Topology
6. Complex Analysis
7. Mechanics
8. Functional Analysis
9. Differential Geometry and more

(ii) ElectiveCourses (ED within the Department Experts)(Illustrative)

1. Discrete Mathematics
2. Number Theory and Cryptography
3. Formal Languages and Automata Theory
4. Programming in C++ and Numerical Methods
5. Fuzzy Sets and Their Applications
6. Mathematical Programming
7. Algebraic Number Theory
8. Java Programming
9. Analytical Number Theory
10. Tensor Analysis and Relativity
11. Stochastic Processes
12. Algebraic Geometry
13. Fluid Dynamics
14. Financial Mathematics
15. Wavelets
16. Mathematical Statistics and more

(iii)ElectiveCourses (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.

Model Syllabus for different Courses of M.Sc Mathematics

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">ALGEBRAIC STRUCTURES</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">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">4</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>I</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="2">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>4</td><td>1</td><td colspan="2">--</td><td colspan="2">5</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">UG level Modern Algebra</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">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="6">UNIT-I : Counting Principle - Class equation for finite groups and its applications - Sylow's theorems (For theorem 2.12.1, First proof only).
Chapter 2: Sections 2.11 and 2.12 (Omit Lemma 2.12.5)</td></tr>
<tr><td colspan="6">UNIT-II : Solvable groups - Direct products - Finite abelian groups- Modules
Chapter 5 : Section 5.7 (Lemma 5.7.1, Lemma 5.7.2, Theorem 5.7.1)
Chapter 2: Section 2.13 and 2.14 (Theorem 2.14.1 only)
Chapter 4: Section 4.5</td></tr>
<tr><td colspan="6">UNIT-III :Linear Transformations: Canonical forms –Triangular form - Nilpotent transformations.
Chapter 6: Sections 6.4, 6.5</td></tr>
<tr><td colspan="6">UNIT-IV :Jordan form - rational canonical form.
Chapter 6 : Sections 6.6 and 6.7</td></tr>
<tr><td colspan="6">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="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>
</table>

Recommended Text	I.N. Herstein. *Topics in Algebra* (II Edition) Wiley Eastern Limited, New Delhi, 1975.
Reference Books	1. M.Artin, *Algebra,* Prentice Hall of India, 1991. 2. P.B.Bhattacharya, S.K.Jain, and S.R.Nagpaul, *Basic Abstract Algebra* (II Edition) Cambridge University Press, 1997. (Indian Edition) 3. I.S.Luther and I.B.S.Passi, *Algebra,* Vol. I –Groups(1996); Vol. II Rings, Narosa Publishing House , New Delhi, 1999 4. D.S.Malik, J.N. Mordeson and M.K.Sen, *Fundamental of Abstract Algebra*, McGraw Hill (International Edition), New York. 1997. 5. N.Jacobson, *Basic Algebra,* Vol. I & II W.H.Freeman (1980); also published by Hindustan Publishing Company, New Delhi.
Website and e-Learning Source	http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics, http://www.opensource.org, www.algebra.com

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

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

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

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

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

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

Strong: Medium: Low:

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="7">REAL ANALYSIS I</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="7">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">4</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>I</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td colspan="2">Lecture</td><td colspan="2">Tutorial</td><td>Lab Practice</td><td>Total</td></tr>
<tr><td colspan="2">4</td><td colspan="2">1</td><td>--</td><td>5</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="7">UG level real analysis concepts</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="7">To work comfortably with functions of bounded variation, Riemann-Stieltjes Integration, convergence of infinite series, infinite product and uniform convergence and its interplay between various limiting operations.</td></tr>
<tr><td colspan="2" rowspan="3">Course Outline</td><td colspan="7">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="7">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>
<tr><td colspan="7">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 integralsign-Lebesgue criteriaon for existence of Riemann integrals. Chapter - 7 : 7.15 to 7.26</td></tr>
</table>

	UNIT-IV :Infinite Series and infinite Products - Double sequences - Double series - Rearrangement theorem for double series - A sufficient condition for equality of iterated series - Multiplication of series – 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 Bansi Lal, *Introduction to Real Analysis*, Satya Prakashan, New Delhi, 1991. 5. Gelbaum, B.R. and J. Olmsted, *Counter Examples in Analysis*, Holden day, San Francisco, 1964. 6. A.L.Gupta and N.R.Gupta, *Principles of Real Analysis*, Pearson Education, (Indian print) 2003.
Website and e-Learning Source	http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics, http://www.opensource.org, www.mathpages.com

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO1: Analyze and evaluate functions of bounded variation and Rectifiable Curves.
CLO2: Describe the concept of Riemann-Stieltjes integral and its properties.
CLO3:Demonstrate the concept of step function, upper function, Lebesgue function and their integrals.
CLO4: Construct various mathematical proofs using the properties of Lebesgue integrals and establish the Levi monotone convergence theorem.
CLO5: Formulate the concept and properties of inner products, norms and measurable functions.

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

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

Extended Professional Component (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* (3^{rd} 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>Credits</td><td>4</td><td>Course Code</td><td></td></tr>
<tr><td>Semester</td><td>II</td><td colspan="4"></td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td colspan="2">Lecture</td><td colspan="2">Tutorial</td><td>Lab Practice</td><td>Total</td></tr>
<tr><td colspan="2">5</td><td colspan="2">1</td><td>--</td><td>5</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">Algebraic Structures</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">To study field extension, roots of polynomials, Galois Theory, finite fields, division rings, solvability by radicals and to develop computational skill in abstract algebra.</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="6">UNIT-I :Extension fields – Transcendence of e.
Chapter 5: Section 5.1 and 5.2</td></tr>
<tr><td colspan="6">UNIT-II : Roots or Polynomials.- More about roots
Chapter 5: Sections 5.3 and 5.5</td></tr>
<tr><td colspan="6">UNIT-III : Elements of Galois theory.
Chapter 5 : Section 5.6</td></tr>
<tr><td colspan="6">UNIT-IV : Finite fields - Wedderburn's theorem on finite division rings.
Chapter 7: Sections 7.1 and 7.2 (Theorem 7.2.1 only)</td></tr>
<tr><td colspan="6">UNIT-V :Solvability by radicals - A theorem of Frobenius - Integral Quaternions and the Four - Square theorem.
Chapter 5: Section 5.7 (omit Lemma 5.7.1, Lemma 5.7.2 and Theorem 5.7.1)
Chapter 7 : Sections 7.3 and 7.4</td></tr>
<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

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">REAL ANALYSIS II</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">CORE V</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">4</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>II</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td colspan="2">Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td colspan="2">4</td><td colspan="2">1</td><td colspan="2">--</td><td>5</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="8">Elements of Real Analysis</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="8">To introduce measure on the real line, Lebesgue measurability and integrability, Fourier Series and Integrals, in-depth study in multivariable calculus.</td></tr>
<tr><td colspan="2" rowspan="4">Course Outline</td><td colspan="8">UNIT-I :Measure on the Real line - Lebesgue Outer Measure - Measurable sets - Regularity - Measurable Functions - Borel and Lebesgue Measurability
Chapter - 2 Sec 2.1 to 2.5 (de Barra)</td></tr>
<tr><td colspan="8">UNIT-II : Integration of Functions of a Real variable - Integration of Non- negative functions - The General Integral - Riemann and Lebesgue Integrals
Chapter - 3 Sec 3.1,3.2 and 3.4 (de Barra)</td></tr>
<tr><td colspan="8">UNIT-III : Fourier Series and Fourier Integrals - Introduction - Orthogonal system of functions - The theorem on best approximation - The Fourier series of a function relative to an orthonormal system - Properties of Fourier Coefficients - The Riesz-Fischer Thorem - The convergence and representation problems in for trigonometric series - The Riemann - Lebesgue Lemma - The Dirichlet Integrals - An integral representation for the partial sums of Fourier series - Riemann's localization theorem - Sufficient conditions for convergence of a Fourier series at a particular point –Cesarosummability of Fourier series- Consequences of Fejes's theorem - The Weierstrass approximation theorem
Chapter 11 : Sections 11.1 to 11.15 (Apostol)</td></tr>
<tr><td colspan="8">UNIT-IV : Multivariable Differential Calculus - Introduction - The Directional derivative - Directional derivative and continuity - The total derivative - The total derivative expressed in terms of partial derivatives - The matrix of linear function - The Jacobian matrix - The chain rule - Matrix form of chain rule - The mean - value theorem for differentiable functions - A sufficient condition for differentiability - A sufficient condition for equality of mixed partial derivatives - Taylor's theorem for functions of R^n to R^1
Chapter 12 : Section 12.1 to 12.14 (Apostol)</td></tr>
</table>

	UNIT-V : Implicit Functions and Extremum Problems : Functions with non-zero Jacobian determinants – The inverse function theorem-The Implicit function theorem-Extrema of real valued functions of severable variables-Extremum problems with side conditions. **Chapter 13 : Sections 13.1 to 13.7 (Apostol)**
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	1. G. de Barra, *Measure Theory and Integration*, Wiley Eastern Ltd., New Delhi, 1981. (for Units I and II) 2. Tom M.Apostol : *Mathematical Analysis*, 2nd Edition, Addison-Wesley Publishing Company Inc. New York, 1974. (for Units III, IV and V)
Reference Books	1. Burkill,J.C.*The Lebesgue Integral*, Cambridge University Press, 1951. 2. Munroe,M.E.*Measure and Integration*. Addison-Wesley, Mass.1971. 3. Roydon,H.L.*Real Analysis*, Macmillan Pub. Company, New York, 1988. 4. Rudin, W. *Principles of Mathematical Analysis*, McGraw Hill Company, New York,1979. 5. Malik,S.C. and Savita Arora. *Mathematical Analysis*, Wiley Eastern Limited. New Delhi, 1991. 6. Sanjay Arora and Bansi Lal, *Introduction to Real Analysis*, Satya Prakashan, New Delhi, 1991
Website and e-Learning Source	http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics, http://www.opensource.org

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

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

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

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

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

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

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

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">PARTIAL DIFFERENTIAL EQUATIONS</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">CORE VI</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">4</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>I</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td colspan="2">Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td colspan="2">4</td><td colspan="2">1</td><td colspan="2">--</td><td>5</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="8">UG level partial differential equations</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="8">To classify the second order partial differential equations and to study Cauchy problem, method of separation of variables, boundary value problems.</td></tr>
<tr><td colspan="2" rowspan="4">Course Outline</td><td colspan="8">UNIT-I :Mathematical Models and Classification of second order equation : Classical equations-Vibrating string – Vibrating membrane – waves in elastic medium – Conduction of heat in solids – Gravitational potential – Second order equations in two independent variables – canonical forms – equations with constant coefficients – general solution
Chapter 2 : Sections 2.1 to 2.6
Chapter 3 : Sections 3.1 to 3.4 (Omit 3.5)</td></tr>
<tr><td colspan="8">UNIT-II :Cauchy Problem : The Cauchy problem – Cauchy-Kowalewsky theorem – Homogeneous wave equation – Initial Boundary value problem- Non-homogeneous boundary conditions – Finite string with fixed ends – Non-homogeneous wave equation – Riemann method – Goursat problem – spherical wave equation – cylindrical wave equation.
Chapter 4 : Sections 4.1 to 4.11</td></tr>
<tr><td colspan="8">UNIT-III :Method of separation of variables: Separation of variable-Vibrating string problem – Existence and uniqueness of solution of vibrating string problem- Heat conduction problem – Existence and uniqueness of solution of heat conduction problem – Laplace and beam equations
Chapter 6 : Sections 6.1 to 6.6 (Omit section 6.7)</td></tr>
<tr><td colspan="8">UNIT-IV : Boundary Value Problems : Boundary value problems – Maximum and minimum principles – Uniqueness and continuity theorem – Dirichlet Problem for a circle , a circular annulus, a rectangle – Dirichlet problem involving Poisson equation – Neumann problem for a circle and a rectangle.
Chapter 8 : Sections 8.1 to 8.9</td></tr>
</table>

	UNIT-V : Green's Function: The Delta function – Green's function – Method of Green's function – Dirichlet Problem for the Laplace and Helmholtz operators – Method of images and eigen functions – Higher dimensional problem – Neumann Problem. **Chapter 10 : Section 10.1 to 10.9**
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	TynMyint-U and Lokenath Debnath, *Partial Differential Equations for Scientists and Engineers* (Third Edition), North Hollan, New York, 1987.
Reference Books	1. M.M.Smirnov, *Second Order partial Differential Equations*, Leningrad, 1964. 2. I.N.Sneddon, *Elements of Partial Differential Equations*, McGraw Hill, New Delhi, 1983. 3. R. Dennemeyer, *Introduction to Partial Differential Equations and Boundary Value Problems*, McGraw Hill, New York, 1968. 4. M.D.Raisinghania, *Advanced Differential Equations*,S.Chand& Company Ltd., New Delhi, 2001. 5. S, Sankar Rao, *Partial Differential Equations*, 2nd Edition, Prentice Hall of India, New Delhi. 2004
Website and e-Learning Source	http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics, http://www.opensource.org, www.mathpages.com

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

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

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

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

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

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

.

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

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">COMPLEX ANALYSIS</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">CORE VII</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">4</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>III</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td colspan="2">Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td colspan="2">4</td><td colspan="2">1</td><td colspan="2">--</td><td>5</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="8">UG level Complex Analysis</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="8">To Study Cauchy integral formula, local properties of analytic functions, general form of Cauchy’s theorem and evaluation of definite integral and harmonic functions</td></tr>
<tr><td colspan="2">Course Outline</td><td colspan="8">UNIT-I : Cauchy’s Integral Formula: The Index of a point with respect to a closed curve – The Integral formula – Higher derivatives. Local Properties of 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="2"></td><td colspan="8">UNIT-II :The general form of Cauchy’s Theorem : Chains and cycles- Simple Continuity - Homology - The General statement of Cauchy’s Theorem - Proof of Cauchy’s theorem - Locally exact differentials- Multiply connected regions - Residue theorem - The argument principle.
Chapter 4 : Section 4 : 4.1 to 4.7
Chapter 4 : Section 5: 5.1 and 5.2</td></tr>
<tr><td colspan="2"></td><td colspan="8">UNIT-III :Evaluation of Definite Integrals and Harmonic Functions Evaluation of definite integrals - Definition of Harmonic function and basic properties - Mean value property - Poisson formula.
Chapter 4 : Section 5 : 5.3
Chapter 4 : Sections 6 : 6.1 to 6.3</td></tr>
<tr><td colspan="2"></td><td colspan="8">UNIT-IV :Harmonic Functions and Power Series Expansions:
Schwarz theorem - The reflection principle - Weierstrass theorem – Taylor’s Series – Laurent series .
Chapter 4 : Sections 6.4 and 6.5
Chapter 5 : Sections 1.1 to 1.3</td></tr>
<tr><td colspan="2"></td><td colspan="8">UNIT-V: Partial Fractions and Entire Functions: Partial fractions - Infinite products – Canonical products – Gamma Function- Jensen’s formula – Hadamard’s Theorem
Chapter 5 : Sections 2.1 to 2.4
Chapter 5 : Sections 3.1 and 3.2</td></tr>
</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	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

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

	UNIT-V:Limit Theorems : Stochastic convergence – Bernaulli law of large numbers – Convergence of sequence of distribution functions – Levy-Cramer Theorems – de Moivre-Laplace Theorem – Poisson, Chebyshev, Khintchine 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*, (2^{nd} Edition) Duxbury Press, New York, 1996. 5. V.K.Rohatgi*An Introduction to Probability Theory and Mathematical Statistics*, Wiley Eastern Ltd., New Delhi, 1988(3^{rd} Print). 6. S.I.Resnick, *A Probability Path*, Birhauser, Berlin,1999. 7. B.R.Bhat , *Modern Probability Theory* (3^{rd} Edition), New Age International (P)Ltd, New Delhi, 1999
Website and e-Learning Source	http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics, http://www.opensource.org, http://www.probability.net

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

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

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

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

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

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

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

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">TOPOLOGY</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">CORE IX</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">4</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>III</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td colspan="2">Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td colspan="2">4</td><td colspan="2">1</td><td colspan="2">--</td><td>5</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="8">Real Analysis</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="8">To study topological spaces, continuous functions, connectedness, compactness, countability and separation axioms.</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="8">UNIT-I : Topological spaces : Topological spaces – Basis for a topology – The order topology – The product topology on X × Y – The subspace topology – Closed sets and limit points.
Chapter 2 : Sections 12 to 17</td></tr>
<tr><td colspan="8">UNIT-II :Continuous functions: Continuous functions – the product topology – The metric topology.
Chapter 2 : Sections 18 to 21 (Omit Section 22)</td></tr>
<tr><td colspan="8">UNIT-III :Connectedness: Connected spaces- connected subspaces of the Real line – Components and local connectedness.
Chapter 3 : Sections 23 to 25.</td></tr>
<tr><td colspan="8">UNIT-IV : Compactness : Compact spaces – compact subspaces of the Real line – Limit Point Compactness – Local Compactness.
Chapter 3 : Sections 26 to 29.</td></tr>
<tr><td colspan="8">UNIT-V: Countability and Separation Axiom: The Countability Axioms – The separation Axioms – Normal spaces – The Urysohn Lemma – The Urysohnmetrization Theorem – The Tietz extension theorem.
Chapter 4 : Sections 30 to 35.</td></tr>
<tr><td colspan="2">Extended Professional Component (is a part ofinternal 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">James R. Munkres, Topology (2nd Edition) Pearson Education Pve. Ltd., Delhi-2002 (Third Indian Reprint)</td></tr>
</table>

Reference Books	1. J. Dugundji ,*Topology* , Prentice Hall of India, New Delhi, 1975. 2. George F.Sinmons, *Introduction to Topology and Modern Analysis*, McGraw Hill Book Co., 1963 3. J.L. Kelly, *General Topology*, Van Nostrand, Reinhold Co., New York 4. L.Steen and J.Subhash, Counter Examples in Topology, Holt, Rinehart and Winston, New York, 1970. 5. S.Willard, *General Topology*, Addison - Wesley, Mass., 1970
Website and e-Learning Source	http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics, http://www.opensource.org , http://en.wikipedia.org

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

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

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

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

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

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

	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: CORE INDUSTRY MODULES

Paper Number: CORE X

Suggestive topics for Core Industry Modules:

1. Industrial Statistics

Recommended Text:

1. Papoulis A. Probability, Random Variables and Stochastic process, Tata McGraw Hill Education Pvt. Ltd., New Delhi
2. Baisnab A., Jas M., Elements of Probability and Statistics, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 1993
3. Fruend John E, Mathematical Statistics, Prentice Hall of India, New Delhi

(iv) **Industrial Processes**

Recommended Text:

1. H.A.Strobel, Chemical Instrumentation: A Systematic approach, 2nd Edition (1973) Addition Wesley, Reading, Mass
2. R.L.Pecsok, L.D. Shields, T.Cavins and L.C.Mcwilliam, 2nd Edition (1976), john Wiley & Sons, New York
3. E.W.Berg, Chemical Methods of Separations, 1st Edition (1963), McGraw Hill, New York

(v) Chemometrics and quality control in industry

Recommended Text:

1. G.D.Christian, Analytical chemistry, 5th edition (1994), John Wiley & Sons, New York
2. M.A. Sharat and D.L. Illuran, Chemometrics, John Wiley, New York
3. Canlcutt and R. Roddy, Statistics for Analytical Chemists, Chapmam and Hall, New York

4. Mathematics of Finance and Insurance

Recommended Text:

1. John C.Hull, Options, Futures and Other Derivatives, Prentice Hall of India Private Limited
2. Sheldon M Ross, An Introduction to the Mathematical Finance, Cambridge University Press
3. Salih N. Nettci, An introduction to the Mathematics of Financial Derivatives, Academic Press, Inc.
4. Robert J.Ellicott and P.Ekkehardkopp, Mathematics of Financial Markets, Springer-Verlag, New York

5. C.D. Daykin, T. Pentikainen and M. Pesonen, Practical Risk Theory for Actuaries, Chapman & Hall.
6. TornaszRolski, HanspterSchmidli, Volker Schmidt and JozefTeugels, Stochastic Processes for insurance and Finance, John Wiley & Sons Limited

5. Performance modelling of communication networks

Recommended Text:

1. Thomas Robertazzi, Computer Networks and Systems: Queuing theory and Performance Evaluation, Springer-Verlag, 2000
2. B.R. Hverkort, Performance of Computer Communication systems (A model based approach), Wiley, 1998

and more.

<table>
<tr><td>Title of the Course</td><td colspan="7">Functional Analysis</td></tr>
<tr><td>Paper Number</td><td colspan="7">CORE XI</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>II</td><td>Credits</td><td>4</td><td>Course Code</td><td></td></tr>
<tr><td>Semester</td><td>IV</td></tr>
<tr><td rowspan="2">Instructional Hours per week</td><td colspan="2">Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td colspan="2">4</td><td colspan="2">1</td><td colspan="2">--</td><td>5</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">Elements of Real Analysis</td></tr>
<tr><td>Objectives of the Course</td><td colspan="7">Toprovidestudentswithastrongfoundationinfunctional analysis, focusingonspaces, operators and fundamental theorems. To develop student’s skills and confidence inmathematicalanalysis and prooftechniques.</td></tr>
<tr><td rowspan="5">Course Outline</td><td colspan="7">UNIT-I :Banach Spaces: The definition and some examples – Continuous linear transformations – TheHahn-Banach theorem – The natural imbedding of N in N^{**}- The open mapping theorem – TheconjugateofanOperator.
Chapter 9:Sections 46-51</td></tr>
<tr><td colspan="7">UNIT-II :HilbertSpaces:Thedefinitionandsomesimpleproperties–Orthogonalcomplements–Orthonormalsets–The conjugate space$H$*-Theadjointofanoperator–self-adjointoperators-Normal andunitaryoperators – Projections.
Chapter10:Sections52-59</td></tr>
<tr><td colspan="7">UNIT-III :Finite-Dimensional Spectral Theory: Matrices – Determinants and the spectrum of an operator –The spectral theorem.
Chapter 11:Sections 60-62</td></tr>
<tr><td colspan="7">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 andsemi-simplicity.
Chapter 12:Sections 64-69</td></tr>
<tr><td colspan="7">UNIT-V: The Structure of Commutative Banach Algebras: The Gelfand mapping – Application of the formula$r(x) = \lim \|x^n\|^{1/n}$– InvolutionsinBanachalgebras-TheGelfand-Neumarktheorem.
Chapter 13:Sections 70-73</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	G.F.Simmons,IntroductiontoTopologyandModernAnalysis,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	**DIFFERENTIAL GEOMETRY**						
Paper Number	**CORE XII**						
Category Core	**Year**	II	**Credits**	4	**Course Code**		
	Semester	IV					
Instructional Hours per week	**Lecture**		**Tutorial**		**Lab Practice**	**Total**	
	4		1		--	5	
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. Struik, D.T. *Lectures on Classical Differential Geometry*, Addison – Wesley, Mass. 1950. 2. Kobayashi. S. and Nomizu. K. *Foundations of Differential Geometry*, Interscience Publishers, 1963. 3. Wilhelm Klingenberg: *A course in Differential Geometry*, Graduate Texts in Mathematics, Springer-Verlag 1978. 4. J.A. Thorpe *Elementary topics in Differential Geometry*,Under-graduate Texts in Mathematics, Springer - Verlag 1979.
Website and e-Learning Source	http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics, http://www.opensource.org, www.physicsforum.com

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

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

CLO2:Evaluate these concepts with related examples.

CLO3: Compose problems on geodesics.

CLO4: Recognize applicability of developable.

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

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

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">MECHANICS</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">CORE XIII</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">4</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>IV</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td colspan="2">Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td colspan="2">4</td><td colspan="2">1</td><td colspan="2">--</td><td>5</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="8">UG level Calculus and Differential equations.</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="8">To study mechanical systems under generalized coordinate systems, virtual work, energy and momentum, to study mechanics developed by Newton, Langrange, Hamilton Jacobi and Theory of Relativity due to Einstein.</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="8">UNIT-I : Mechanical Systems : The Mechanical system- Generalised coordinates – Constraints - Virtual work - Energy and Momentum
Chapter 1 : Sections 1.1 to 1.5</td></tr>
<tr><td colspan="8">UNIT-II : Lagrange's Equations: Derivation of Lagrange's equations- Examples- Integrals of motion.
Chapter 2 : Sections 2.1 to 2.3 (Omit Section 2.4)</td></tr>
<tr><td colspan="8">UNIT-III : Hamilton's Equations : Hamilton's Principle - Hamilton's Equation - Other variational principle.
Chapter 4 : Sections 4.1 to 4.3 (Omit section 4.4)</td></tr>
<tr><td colspan="8">UNIT – IV : Hamilton-Jacobi Theory : Hamilton Principle function – Hamilton-Jacobi Equation - Separability
Chapter 5 : Sections 5.1 to 5.3</td></tr>
<tr><td colspan="8">UNIT-V : Canonical Transformation : Differential forms and generating functions – Special Transformations– Lagrange and Poisson brackets.
Chapter 6 : Sections 6.1, 6.2 and 6.3 (omit sections 6.4, 6.5 and 6.6)</td></tr>
<tr><td colspan="2">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">D. Greenwood, Classical Dynamics, Prentice Hall of India, New Delhi, 1985.</td></tr>
</table>

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

Title of the Course		**PROJECT WITH VIVA VOCE**						
Paper Number		**CORE IVX**						
Category	Core	**Year**	II	**Credits**	4	**Course Code**		
		Semester	IV					
Instructional Hours per week		**Lecture**		**Tutorial**		**Lab Practice**	**Total**	
		4				--	5	
Pre-requisite		UG Level Mathematics						

Elective Courses

Group A

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">1.NUMBER THEORY AND CRYPTOGRAPHY</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">ELECTIVE I</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">ELECTIVE COURSE</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>I</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td>4</td><td colspan="2">1</td><td colspan="2">--</td><td>5</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">UG level Number Theory</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">To provide an introduction to analytic number theory and recent topics of Cryptography with applications.</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="6">Unit I : Introduction – Conjectures, Theorems, and Proofs-Well Ordering and Induction- Sigma Notation and Product Notation- Binomial Coefficients- Greatest Integer Functions- Divisibility, Greatest Common Divisor, Euclid ‘s algorithm; GCD via Euclid ‘s algorithm- Least Common Multiple- Representation of integers.
Chapter 1: Sections1.1-1.6 and Chapter 2: Sections 2.2-2.4 of Text Book 1.</td></tr>
<tr><td colspan="6">Unit II: Introduction –Primes, Prime Counting Function, Prime Number Theorem; Test of Primality by Trial Division –Sieve of Eratosthenes, Canonical Factorization, Fundamental Theorem of Arithmetic.
Chapter 3: Sections 3.1-3.3 of Text Book 1.</td></tr>
<tr><td colspan="6">Unit III : Congruences and Equivalence Relations-Linear Congruences -Linear Diophantine Equations and the Chinese Remainder Theorem- Polynomial Congruences – Modular Arithmetic: Fermat’s Theorem –Wilson’s Theorem and Fermat Numbers.
Chapter 4: Sections 4.2-4.7 of Text Book 1.</td></tr>
<tr><td colspan="6">Unit IV: Introduction-Sigma Function. Tau Functions. Dirichlet Product –Dirichlet Inverse, Moebius Function, Euler’s Function, Euler’s Theorem.
Chapter 5: Sections 5.1 – 5.3 of Text Book 1.</td></tr>
<tr><td colspan="6">Unit V: Cryptography: Introduction – Some simple crypto systems –Enciphering Matrices–The idea of Public key Cryptography– RSA.
Chapter III: Sections 1-2 and Chapter IV: Sections 1-2 of Text Book 2.</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	1. Neville Robbins; Beginning Number Theory, Second Edition, Narosa, 2006. 2. Neal Koblitz: A Course in Number Theory and Cryptography, Second edition, Springer-Verlag Newyork-1994.
Reference Books	1. Tom. M. Apostol; Introduction to analytic Number theory, Narosa Publishing House, 1998. 2. Ivan Nivan, H. S. Zuckerman and H. L. Montgomery; An introduction to the theory of Number, 5th Ed paperback-International Edition, 1991.
Website and e-Learning Source	https://www.encyclopedia.com/science/encyclopedias-almanacs-transcripts-and-maps/applications-number-theory-cryptography, https://mathstats.uncg.edu/number-theory/ https://en.wikipedia.org/wiki/Number_theory https://en.wikibooks.org/wiki/Cryptography

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO 1: understand the problems in elementary number theory

CLO 2: apply elementary number theory to Cryptography

CLO 3:develop a deep understanding of theoretical basis of number theory and cryptography.

CLO 4:identify how number theory is related and applied in Cryptography

CLO 5: develops the knowledge of encryption and decryption and their application in Managing the security of data.

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

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">2. GRAPH THEORY AND APPLICATIONS</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">ELECTIVE I</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">ELECTIVE COURSE</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>I</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>4</td><td colspan="2">1</td><td colspan="2">--</td><td colspan="2">5</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="8">UG level Graph Theory</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="8">To study the graph theoretical concepts and algorithms that help to model real life situations.</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="8">Unit I: Trees, Cut Edges and Bonds, Cut Vertices, Cayley’s Formula –Applications: The Connector Problem – Connectivity, Blocks – Applications: Construction of Reliable Communication Networks.
Chapter 2 : Sections 2.1-2.5 and Chapter 3: Sections 3.1-3.3</td></tr>
<tr><td colspan="8">Unit II: Euler Tours, Hamiltonian Cycles –Applications: The Chinese Postman Problem, The Travelling Salesman Problem.
Chapter 4: Sections 4.1-4.4.</td></tr>
<tr><td colspan="8">Unit III: Matching’s, Matching’s and Coverings in Bipartite Graphs, Perfect Matching – Applications: The Personnel Assignment Problem, The Optimal Assignment Problem.
Chapter 5: Sections 5.1-5.5</td></tr>
<tr><td colspan="8">Unit IV: Chromatic Number, Brook’s Theorem, Hajos’ Conjecture, Chromatic Polynomials, Girth and Chromatic Number – Applications: A Storage Problem.
Chapter 8: Sections 8.1-8.6.</td></tr>
<tr><td colspan="8">Unit V: Directed Graphs, Directed Paths, Directed Cycles – Applications: A Job Sequencing Problem, Designing as Efficient Computer Drum, Making a Road System One-Way.
Chapter 10: Sections 10.1-10.6.</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>
</table>

Recommended Text	J.A Bondy and U.S.R Murty, Graph Theory with Applications, North Holland, 1976.
Reference Books	1. John Clark and D. Allan Holton; Graph theory World Scientific Publishing Co. Pvt.Ltd, 1991. 2. Narsingh Deo; Graph Theory with Applications to Engineering and Computer Science, Prentice Hall, 1974.
Website and e-Learning Source	https://www.zib.de/groetschel/teaching/WS1314/BondyMurtyGTWA.pdf, http://ignited.in/I/a/252519, https://www.mygreatlearning.com/blog/application-of-graph theory/https://in.coursera.org/learn/graphs, https://neo4j.com/blog/top-13-resources-graph-theory-algorithms/

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO 1:study the properties of Trees, Connectivity and Blocks with its applications.

CLO 2:discuss Euler tour, Hamiltonian cycles and its suitable applications.

CLO 3:understand the concepts of Matching's, Coverings and Perfect Matching's.

CLO 4:apply domain knowledge in Chromatic number, Brook's Theorem, Hajos' Conjecture

and Chromatic polynomials.

CLO 5:define Directed graphs, Directed paths and Directed cycles and apply results to Practical problems.

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

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">3. FORMAL LANGUAGES AND AUTOMATA THEORY</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">ELECTIVE I</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">ELECTIVE COURSE</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>I</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>4</td><td colspan="2">1</td><td colspan="2">--</td><td colspan="2">5</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="8">UG level Discrete Mathematics, e.g., graphs, trees, logic, and proof techniques.</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="8">To understand the notion of effective computability by studying Finite Automata, Regular Expressions, Regular Languages and Free Grammars.</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="8">Unit I: Why Study Automata Theory? -Introduction to Formal Proof- Additional Forms of Proof-Inductive Proofs.
Chapter 1: Sections 1.1 – 1.4</td></tr>
<tr><td colspan="8">Unit II: An Informal Picture of Finite Automata-Deterministic Finite Automata-Non-Deterministic Finite Automata-An Application: Text Search.
Chapter 2: Sections 2.1 – 2.4</td></tr>
<tr><td colspan="8">Unit III: Regular Expressions-Finite Automata and Regular Expressions-Application of Regular Expressions-Algebraic Laws of Regular Expressions.
Chapter 3: Sections 3.1 – 3.4</td></tr>
<tr><td colspan="8">Unit IV: Proving Languages are Not Regular-Closure Properties of Regular Languages-Decision Properties of Regular Languages-Equivalence and Minimization of Automata.
Chapter 4: Sections 4.1 – 4.4</td></tr>
<tr><td colspan="8">Unit V: Context-Free Grammars-Parse Trees-Application of Context-Free Grammar-Ambiguity in Grammars and Languages.
Chapter 5: Sections 5.1 – 5.4</td></tr>
</table>

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations 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. E. Hopcroft, R. Motwani and J.D. Ullman; Introduction to Automata Theory, Languages, and Computation. Second Edition, Pearson Edition, 2001.
Reference Books	1. P.K. Srimani and S.F.B. Nasir; A text book on Automata theory, Cambridge University press, 2007. 2. J.P. Tremblay and R. Manohar; Discrete Mathematical Structures with Applications to Computer Science, McGraw Hill Education (India) Pvt Ltd, 2017.
Website and e-Learning Source	https://en.wikipedia.org/wiki/Automata_theory, https://en.wikiversity.org/wiki/Automata_theory,

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO 1: understand the basic properties of formal languages and grammars.

CLO 2: make grammars to produce strings from a specific language..

CLO 3: design sample Automata

CLO 4: minimize Finite Automata and grammar of context-free languages.

CLO 5: differentiate regular, context-free and recursively enumerate languages.

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

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">4.PROGRAMMING IN C++ AND NUMERICAL METHODS</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">ELECTIVE I</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">ELECTIVE COURSE</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>I</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td colspan="2">Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td colspan="2">4</td><td colspan="2">---</td><td colspan="2">1</td><td>5</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="8">Basics of Differentiation and Integration</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="8">To develop the skills of solving algebraic, transcendental, differential and integral equations numerically and C++ Programme.</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="8">Unit I: Method of False Position - Bisection Method - Iterative Method - Newton-Raphson Method - Graeffe Root Squaring Method - Programme for Bisection Method.
Chapter 2: Sections 2.2, 2.3, 2.4, 2.5, 2.8 and 2.11.1</td></tr>
<tr><td colspan="8">Unit II: Gauss Elimination Method – Jordan Method – Jacobi Iteration Method – Gauss-Seidel Iterative Method – Eigen Value Problem – Programme for Gauss Elimination Method.
Chapter 3: Sections 3.3, 3.4, 3.7, 3.8, 3.13 and 3.15.1.</td></tr>
<tr><td colspan="8">Unit III: Curve Fitting -Fitting a Straight Line by the Method of Group Averages – Least Square Curve Fitting Method – Method of Moments – Weighted Least Squares Method – Programme to Fit a Straight Line Using Group Average Method.
Chapter 4: Sections 4.1, 4.2, 4.3, 4.4, 4.5 and 4.6.1</td></tr>
<tr><td colspan="8">Unit IV: Finite Differences – E, μ and D Operators – Gregory-Newton Forward Interpolation Formula - Gregory-Newton Backward Interpolation Formula – Gauss Forward Interpolation Formula – Gauss Backward Interpolation Formula – Programme for Interpolating Using Gregory-Newton Forward Interpolation.
Chapter 5: Sections 5.1, 5.2, 5.7, 5.8, 5.9, 5.10 and 5.23.1</td></tr>
<tr><td colspan="8">Unit V: Numerical Differentiation – Trapezoidal – Simpson’s 1/3 Rule - Simpson’s 3/8 Rule – Romberg Formula – Programme to Find Derivative at Initial Point by Newton Forward Formula.
Chapter 6: Sections 6.1, 6.6, 6.7, 6.8, 6.11 and 6.16.1</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>
</table>

Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill.
Recommended Text	Nita H. Shah, Numerical Methods With C++ Programming, PHI Learning Private Limited, 2009.
Reference Books	1. C.F.Gerald and P.O.Wheatly; Applied Numerical Analysis, Addison Wesley, Fifth Edition, 1998. 2. V. Rajaraman, Computer Oriented Numerical Methods, PHI, 3rd Edition, 2006. 3. E.V.Krishnamurthy and S.K. Sen, Computer Based Numerical Algorithms, Affiliated East-west Press Pvt Ltd, 1st Ediiton, 2009. 4. M.K.Jain, S.R.K.Iyengar and R.K.Jain; Numerical Methods for Scientific and Engineering Computation, New Age International Publishers, Fourth Edition, 2013.
Website and e-Learning Source	https://www.codesansar.com/numerical-methods/, https://www.phindia.com/Books/BookDetail/9788120335967/numerical-methods-with-c--programming-shah, https://www.udemy.com/course/learn-numerical-methods-using-c/

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO 1: understandthe iterative methods for finding the roots of transcendental and algebraicequations with C++ Programme.

CLO 2: solve a system of linear algebraic equations and study Convergence of iterative methods.

CLO 3: fit a Curve for given set of data through C++ Programme.

CLO 4: approximate the polynomial by interpolation method via C++ Programme.

CLO 5: analyse Numerical Differentiation and Integration using Programming in C++.

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

Group B

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="7">1. Lie Groups and Lie Algebras</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="7">ELECTIVE II</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">ELECTIVE COURSE</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>I</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td>4</td><td colspan="2">---</td><td colspan="2">1</td><td>5</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="7">Basics set theory and Groups</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="7">To introduce the concept of Lie Algebras and Lie Groups and to study their properties</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="7">Unit I:Lie groups, Subgroups, and cosets, Action of Lie groups on manifolds and representations, Orbits and homogeneous spaces, Left, right, and adjoint action, Classical groups.
Chapter 2: 2.1-2.5</td></tr>
<tr><td colspan="7">Unit II: : Exponential map, The commutator, Adjoint action and Jacobi identity.
Chapter 3: 3.1-3.3</td></tr>
<tr><td colspan="7">Unit III: Subalgebras, ideals, and centre, Lie algebra of vector fields, Stabilizers and the center.
Chapter 3: 3.4-3.6</td></tr>
<tr><td colspan="7">Unit IV: Campbell-Hausdorff formula, Fundamental theorems of Lie theory, Complex and real forms, Example: $\boldsymbol{so}(3, \mathbb{R})$, $\boldsymbol{su}(2)$, and $\boldsymbol{sl}(2, \mathbb{C})$
Chapter 3: 3.7-3.10</td></tr>
<tr><td colspan="7">Unit V: Basic definitions, Operations on representations, Irreducible representations, Intertwining operators and Schur lemma.
Chapter 4 : 4.1-4.4</td></tr>
</table>

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill.
Recommended Text	Introduction to Lie Algebras and Lie Groups
Reference Books	1. Lie Groups , Lie Algebras, and Representations. 2. Introduction to Lie Algebras and representation theory. 3. Introduction to Lie Algebras
Website and e-Learning Source	www.math.sunysb.edu/"kirillov

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO 1: understandthe definition of Lie Groups and Lie Algebras.

CLO 2: studied exponential map, The commutator, Adjoint action and Jacobi identity.

CLO 3: gained the Subalgebras, ideals, and centre, Lie algebra of vector fields, Stabilizers and the center.

CLO 4: Campbell-Hausdorff formula, Fundamental theorems of Lie theory, Complex and real forms, Example: $\boldsymbol{so}(3, \mathbb{R})$, $\boldsymbol{su}(2)$, and $\boldsymbol{sl}(2, \mathbb{C})$

CLO 5: Operations on representations, Irreducible representations, Intertwining operators and Schur lemma.

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

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">2.Mathematical Programming</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">ELECTIVE II</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">ELECTIVE COURSE</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>I</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td>Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>4</td><td colspan="2">---</td><td>1</td><td colspan="2">5</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="8">UG level Operations Research</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="8">To understand the methods of optimization techniques, the theory of optimization techniques and familiar in solving techniques, analysing the results and propose recommendations to the decision making process.</td></tr>
<tr><td colspan="2" rowspan="2">Course Outline</td><td colspan="8">Unit I:Integer Linear Programming
Introduction - Illustrative application integer programming solution algorithms, Branch and Bound Algorithm –zero-one implicit enumeration algorithm- Cutting plane algorithm
Chapter 9: 9.1, 9.2.1, 9.2.3</td></tr>
<tr><td colspan="8">Unit II: Deterministic Dynamic Programming
Introduction- Recursive nature of computation in DP- Forward and Backward recursion- Selected DP applications cargo- Loading model- - Work force size model- Equipment – replacement model- Inventory models
Chapter10:10.1 to 10.3</td></tr>
</table>

	Unit III: Decision Analysis and Games: Decision environment- Decision making under certainty (Analytical Hierarchy approach). Decision making under risk- Expected value criterion- Variations of the expected value criterion – Decision under uncertainty Game theory. Optimal solution of Two – Person zero-Sum games- Solution of mixed strategy games **Chapter 14**: 14.1 to 14.4
	Unit IV: Simulation Modeling : What is simulation? Monte Carlo Simulation- Types of simulation- Elements of Discrete Event simulation- Generic definition of events- Sampling from probability distributions. Methods for gathering statistical observations – Sub Interval method- Republican method- Regenerate (Cycle Method)- Simulation Languages **Chapter 18**: 18.1 to 18.7
	Unit V: Nonlinear Programming Algorithm Unconstrained nonlinear Programming algorithm- Direct search method- Gradient method Constrained algorithms: Separable programming- Quadratic programming- Geometric programming- Stochastic programming- Linear Combination Method- SUMT algorithm **Chapter** 21: 21.1, 21.2
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	Hamdy A.Taha, Operation Research an Introduction, 6th edition, University of Arkansas Fayetteville

Reference Books	1. F.S. Hillier and G. J. Liberman Introduction to operation Research 4th Edition, Mc Gno Hill Book Compnany, New York, 1989 2. B.E.Gillett, Operation Research- A computer oriented algorithmic Approach, TMH Edition NewDelhi, 1976
Website and e-Learning Source	www.pearsonglobaleditions.com

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO 1: Integer Linear Programming

CLO 2: Deterministic dynamic Programming

CLO 3: Decision analysis and games

CLO 4: Simulation Modeling

CLO 5: Nonlinear Programming algorithm

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

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="7">3. Fuzzy Sets and their Applications</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="7">ELECTIVE II</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">ELECTIVE COURSE</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>III/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>4</td><td colspan="2">---</td><td>1</td><td colspan="2">5</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="7">UG level sets and functions</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="7">To introduce the concept of uncertainty and fuzziness in logic and to study fuzzy arithmetic, fuzzy relations and construction of fuzzy sets</td></tr>
</table>

Course Outline	**Unit I:**Crisp sets and fuzzy sets Overview of Classic sets, Membership function, Height of a fuzzy set- Normal and subnormal fuzzy sets-Support –Level sets, fuzzy points, α cuts-Decomposition Theorems, Extension Principle
	Unit II: Operation on Fuzzy sets Standard fuzzy operations- Union, intersection and complement- Properties De. Morgan's law- α cuts of fuzzy operation
	Unit III: Fuzzy relation Cartesian products, Crisp relations-cardinality- operations and properties of crisp and Fuzzy relations. Image and inverse image of Fuzzy sets- Various definitions of fuzzy operations-Generalizations- Non intersecting Fuzzy sets, Tolerance and equivalence relations.
	Unit IV: Decision making in Fuzzy environment General Discussion- Individual Decision making- multi person decision making- multi criteria decision making - multi stage decision making- fuzzy ranking methods-fuzzy linear programming
	Unit V: Applications Medicine- Economics-Fuzzy systems and Genetic applications- Fuzzy Regression- Interpersonal communication-Other Applications
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	Georgr J. Klir and Bo Tuan, Fuzzy Sets and Fuzzy Logic Theory and applications, PHI Leaning private Limited, New delhi, 2009

Reference Books	1. A.K. Bhargava: Fuzzy Set Theory, Fuzzy Logic and their Applications, published by S. Chand Pvt limited, 2013 2. S. Rajasekaran& Y.A. VijiaylakshmiPai, Neural Networks, Fuzzy logic and genetic algorithms, Prentice Hall of India
Website and e-Learning Source	-

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO 1: Crisp sets and fuzzy sets

CLO 2: Operation on Fuzzy sets

CLO 3: Fuzzy relation

CLO 4: Decision making in Fuzzy environment

CLO 5: Applications

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

Title of the Course		**4.Discrete Mathematics**						
Paper Number		**ELECTIVE II**						
Category	**ELECTIVE COURSE**	**Year**	II	**Credits**	**3**	**Course Code**		
		Semester	III/IV					
Instructional Hours per week		**Lecture**		**Tutorial**		**Lab Practice**		**Total**
		4		**---**		**1**		**5**
Pre-requisite		UG level sets and functions						

Objectives of the Course	To understand the basic idea of semi groups, monoids, Lattices, Boolean Algebra, Grammer and Languages
Course Outline	**Unit I:**Semigroups and Monoids: Definition and examples of semigroups and monoids(including those pertaining to concatenation operation), Homomorphism of semigroups and monoids, Congruence relation and quotient semigroups, Subsemigroup and submonoids. **Chapter 3:**3.2.1 to 3.2.3
	Unit II: Lattices: Lattices as partially ordered sets and their properties, Lattices as algebraic systems, sublattices, Direct products and homomorphisms, Some special lattices such as complete, complemented and distributive lattices **Chapter4:** 4.1, 4.1.3 to 4.1.5
	Unit III: Grammars and Languages Discussion of Grammars, Formal definition of a language, Notions of Syntax analysis. **Chapter 3:** 3.3.1 to 3.3.3
	Unit IV: Boolean Algebra Boolean Algebra as Lattices, Various Boolean identities, The switching algebra example, Sub-algebras, direct product and homomorphisms, join-irreducible elements, Atoms and minterms, Boolean forms and their equivalence, Minterms Boolean forms, sum of products, canonical forms, Minimization of Boolean forms **Chapter 4**: 4.2.1 to 4.2.2
	Unit V: Boolean functions: Boolean forms and Free Boolean Algebras, Values of Boolean expressions and Boolean functions. **Chapter 4**: 4.3.1 to 4.3.2
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	J.P Trumbly and R. Monohar , Discrete Mathematical Structure and its application to computer Science, Tata McGraw Hills, New Delhi.
Reference Books	1 Kenneth H Rosan, Discrete Mathematics and its applications, 7^{th} edition, WCB/McGraw Hill Educations, New York 2008 2 C.L. Liu, Elements of Discrete Mathematics, Tata McGraw-Hill Publishing Company Limited
Website and e-Learning Source	-

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO 1: Semigroups and Monoids

CLO 2: Lattices

CLO 3: Grammars and Languages

CLO 4: Boolean Algebra

CLO 5: Boolean functions:

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

Group C

Title of the Course		1. **ALGEBRAIC TOPOLOGY**					
Paper Number		Elective III					
Category	Elective	Year	I			Course	

<table>
<tr><td colspan="2"></td><td>Semester</td><td>II</td><td>Credits</td><td>3</td><td>Code</td><td>EC3</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week (hrs)</td><td>Lecture</td><td>Tutorial</td><td colspan="2">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>4</td><td>1</td><td colspan="2">-</td><td colspan="2">5</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">Fundamentals of group theory and Topology</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">Learn how basic geometric structures may be studied by transforming them into algebraic questions.
• Learn basics of homology theory and apply it to get a generalization of Eulers formula to a general polyhedral.
• Learn to associate various groups namely homology groups of various dimensions and the homotopy group- the fundamental group to every topological space.
• Learn that two objects that can be deformed into one another will have the same homology group.
• Learn Brouwer fixed point theorem and related results.</td></tr>
<tr><td colspan="2" rowspan="4">Course Outline</td><td colspan="6">Unit I
Geometric Complexes and Polyhedra: Introduction. Examples, Geometric Complexes and Poly- hedra, Orientation of geometric complexes;
Chapter 1: Sections 1.1 to 1.4</td></tr>
<tr><td colspan="6">Unit II
Simplicial Homology Groups: Chains, cycles, Boundaries and homology groups, Examples of homology groups, The structure of homology groups- Simplicial Homology Groups(Contd.): The Euler Poincare's Theorem, Pseudomanifolds and the homology groups of S n ;
Chapter 2: Sections 2.1 to 2.5</td></tr>
<tr><td colspan="6">Unit III
Simplicial Approximation: Introduction, Simplicial approximation, Induced homomorphisms on the Homology groups, The Brouwer fixed point theorem and related results
Chapter 3: Sections 3.1 to 3.4</td></tr>
<tr><td colspan="6">Unit IV
The Fundamental Group: Introduction, Homotopic Paths and the Fundamental Group, The Covering Homotopy Property for S 1 , Examples of Fundamental Groups
Chapter 4: Sections 4.1 to 4.4</td></tr>
</table>

	Unit V Covering spaces- The definitions and some examples- Properties of covering spaces – Classification of covering space- universal covering space. **Chapter 5: Sections 5.1 to 5.4**
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 Class hour)
Skills acquired from this course	Knowledge, Problem Solving
Recommended Text	Fred h. Croom, Basic Concepts of Algebraic Topology, utm, springer - verlag, ny, 1978.
Reference Books	1. Eilenberg S, Steenrod N.: Foundations of Algebraic Topology; Princeton Univ. Press; 1952 2. S.T. Hu: Homology Theory; Holden-Day; 1965 3. Massey W.S.: Algebraic Topology : An Introduction; Springer Verlag NY; 1977 4. C.T.C. Wall: A Geometric Introduction to Topology; Addison-Wesley Pub. Co. Reading Mass;1972

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO 1: Geometric Complexes and Polyhedra

CLO 2: Simplicial Homology Groups

CLO 3: Simplicial Approximation

CLO 4: The Fundamental Group

CLO 5: Covering spaces

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

CLO2	3	2	3	2	1	2	3	2	2
CLO3	3	2	3	2	1	2	3	2	2
CLO4	3	2	3	2	1	2	3	2	2
CLO5	3	2	3	2	1	2	3	2	2

Title of the Course		**2.MATHEMATICAL STATISTICS**					
Paper Number		**Elective III**					
Category	Elective	**Year**	I	**Credits**	3	**Course Code**	EC3
		Semester	II				

<table>
<tr><td>Instructional Hours per week (hrs)</td><td>Lecture</td><td>Tutorial</td><td>Lab Practice</td><td>Total</td></tr>
<tr><td></td><td>4</td><td>1</td><td>-</td><td>5</td></tr>
<tr><td>Pre-requisite</td><td colspan="4">Knowledge in UG Level</td></tr>
<tr><td>Objectives of the Course</td><td colspan="4">To impart the statistical concepts and results with rigorous Mathematical treatment.
To enable the real-life applications of Statistics</td></tr>
<tr><td rowspan="5">Course Outline</td><td colspan="4">Unit I
Sample Moments and their functions- The notion of Sample and statistic-The distribution of arithmetic mean and independent normally distributed random variables- The χ^2 distribution-The distribution of the statistic ($\bar{X}, S$); Student's t- distribution- Fisher's Z-distribution-The distribution of $\bar{X}$ for some non-normal populations.
(Section 9.1 – 9.8)</td></tr>
<tr><td colspan="4">Unit II
The distribution of sample moment and sample and sample correlation coefficients of a two-dimensional normal population-The distribution of regression coefficients- Limit distribution of sample moments. Order Statistics-The notion of an order statistic – the empirical distribution function –Stochastic convergence of sample quantiles.
(Section 9.9, 9.10 and 10.1 – 10.4)</td></tr>
<tr><td colspan="4">Unit III
Limit distribution of sample quantiles - The limit distribution of successive sample elements- the joint distribution of a group of quantiles – The distribution of the sample range- Tolerance limits-Glivenko Theorem - The theorems of Kolmogorov and Smirnov-Renyi's theorem- the problem of k-samples.
(Section 10.5 – 10.13)</td></tr>
<tr><td colspan="4">Unit IV
An Outline of the Theory of Runs- the notion of a run- the probability distribution of the number of runs - the expected value and the variance of the runs.
Section 11.1 -11.4</td></tr>
<tr><td colspan="4">Unit V
Significance Test- The concepts of a statistical test- parametric test for small samples and large samples- The χ^2 test- Test of the Kolmogorov and Smirnov Type- the wald Wolfovitz and
Mann –Whitney test- Independence test by contingency tables.
(Section 12.1 -12.7)</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 Class hour)
Skills acquired from this course	Knowledge, Problem Solving
Recommended Text	**M. Fisz,Probability Theory and Mathematical Statistics**, John Wiley and Sons, New york, 1963.
Reference Books	1. Gupta. S.C. &Kapoor,V.K. (2002) . Fundamentals of Mathematical Statistics, Sultan Chand & Sons Pvt. Ltd. New Delhi 2. Mood A. M &Graybill F. A &Boes D. G (1974) : Introduction to theory of Statistics, Mcgraw Hill. 3. Hogg R. V. & Craig A. T. 1988) : Introduction to Mathematical Statistics, Mcmillan. Bansilal andArora (1989).New Mathematical Statistics, SatyaPrakashan, New Delhi.

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO 1: Sample Moments and their functions

CLO 2: Limit distribution of sample moments

CLO 3: Limit distribution of sample quantiles

CLO 4: An Outline of the Theory of Runs

CLO 5: Significance Test

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

CLO3	3	2	3	2	1	2	3	2	2
CLO4	3	2	3	2	1	2	3	2	2
CLO5	3	2	3	2	1	2	3	2	2

Title of the Course		**3.STATISTICAL DATA ANALYSIS USING RPROGRAMMING**					
Paper Number		**Elective III**					
Category	Elective	**Year**	I			**Course Code**	EC3
		Semester	II	**Credits**	3		

Instructional Hours per week (hrs)	**Lecture**	**Tutorial**	**Lab Practice**	**Total**
	4	1	-	5
Pre-requisite	**Basic knowledge in Statistics and Mathematics**			
Objectives of the Course	After successful completion of the course students should be able to (i) understand the basics in R programming.(ii) Import, review, manipulate and summarize datasets in R.(iii) Explore datasets to create testable hypotheses and identify appropriate statistical tests.(iv) Perform appropriate statistical tests using R. (v) Create and edit visualizations with R.			
Course Outline	**Unit I** Getting Started - Installing R- Running R -The Comprehensive R Archive Network - Manuals- Contributed documentatio -Getting help in R -Worked examples of functions- Demonstrations of R functions- Packages in R - Contents of packages - Installing packages - Command line versus scripts- Data editor- Changing the look of the R screen - Good housekeeping - Linking to other computer languages. **Section 1.1 – 1.11**			
	Unit II Essentials of the R Language - Calculations - Complex numbers in R - Rounding - Arithmetic -Modulo and integer quotients --Variable names and assignment - Operators - Integers – Factors. Writing R functions- Arithmetic mean of a single sample - Median of a single sample - Geometric mean - Harmonic mean - Variance - Degrees of freedom - Variance ratio test . **Section 2.1 and 2.15 (2.15 .1 – 2.15.7)**			
	Unit III Graphics.Plots with two variables - Plotting with two continuous explanatory variables: Scatterplots - Adding other shapes to a plot- Drawing mathematical functions - Shape and size of the graphics window - Plotting with a categorical explanatory variable - Plots for single samples - Plots with multiple variables- Special plots. **Section 5.1- 5.11**			

	Unit IV Probability functions - Continuous probability distributions - Normal distribution - The central limit theorem - Maximum likelihood with the normal distribution - Generating random numbers with exact mean and standard deviation - Comparing data with a normal distribution - Other distributions used in hypothesis testing - The chi-squared distribution - Fisher's F distribution - Student's t distribution - The gamma distribution - The exponential distribution -The beta distribution - The Cauchy distribution - The lognormal distribution - The logistic distribution - The log-logistic distribution - The Weibull distribution - Multivariate normal distribution -The uniform distribution - Plotting empirical cumulative distribution functions **Section 7.3**
	Unit V Discrete probability distributions - The Bernoulli distribution - The binomial distribution - The geometric distribution - The hyper geometric distribution - The multinomial distribution - The Poisson distribution - The negative binomial distribution - The Wilcoxon rank-sum statistic- Analysis of Variance- ANOVA (one- way) **Section 7.4 and Section 11**
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 Class hour)
Skills acquired from this course	Knowledge, Problem Solving
Recommended Text	Michael J. Crawley Imperial College London at Silwood Park, UK A John Wiley & Sons, Ltd., Publication This edition first published 2013

Reference Books	1. Sudha G. Purohit et.al., Statistics Using R, Narosa Publishing House, , India(2008) 2. John Verzani, simple R-Using R for Introductory Statistics, (http://www.math.csi.cuny.edu/Statistics/R/SimpleR/Simple.) 3. W. N. Venables, D. M. Smith and the R Core Team, An Introduction to R , Notes on R: A Programming Environment for Data Analysis and Graphics, Version 2.15.2 (2012-10-26) (http://www.r-project.org) 4. D. E. Knuth: The TEX Book. Addison-Wesley, Reading, second edition, 1986
Online reference	http://www.bio.ic.ac.uk/research/mjcraw/therbook/index.htm

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO 1: The Comprehensive R Archive Network

CLO 2: Essentials of the R Language

CLO 3: Graphics,Plots with two variables

CLO 4: Probability functions

CLO 5: Discrete probability distributions

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

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">4.TENSOR ANALYSIS AND RELATIVITY</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">Elective</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td>Course</td><td rowspan="2">EC3</td></tr>
<tr><td>Semester</td><td>II</td><td>Code</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week (hrs)</td><td>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td>4</td><td colspan="2">1</td><td colspan="2">-</td><td>5</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">Basic knowledge in Analytical geometry</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">After successful completion of the course students should be able to understand the basics concepts of Tensor in various fields like Cartesian Tensor,Tensor in Physics, and Tensor in Analytic Solid Geometry, General Tensor, Tensor in Relativity and Geodesics and Its Coordinate.</td></tr>
<tr><td colspan="2">Course Outline</td><td colspan="6">Unit I
Cartesian Tensor: Introduction- Transformation of Coordinates- Relations Between the Direction Cosines- Transformation of Velocity Components - First-Order Tensors - Second-Order Tensors - Notation for Tensors - Algebraic Operations on Tensors- Sum and Difference of Tensors - Product of Tensors - Quotient Law of Tensors-Contraction Theorem - Symmetric and Skew-Symmetric Tensor- Alternate Tensor- Kronecker Tensor -Relation Between Alternate and Kronecker Tensors- Matrices and Tensors of First and Second Orders - Product of Two Matrices- Scalar and Vector Inner Product - Two Vectors - Scalar Product- Vector Product- Tensor Fields - Gradient of Tensor Field - Divergence of Vector Point Function - Curl of Vector Point Function- Tensorial Formulation of Gauss’s Theorem - Tensorial Formulation of Stoke’s Theorem.
Chapter : 2</td></tr>
<tr><td colspan="2"></td><td colspan="6">Unit II
Tensor in Physics: Kinematics of Single Particle - Momentum - Acceleration - Force - Kinetic Energy and Potential Energy - Work Function and Potential Energy - Momentum and Angular Momentum - Moment of Inertia - Strain Tensor at Any Point - Stress Tensor at any Point P - Normal Stress - Simple Stress - Shearing Stress -Generalised Hooke’s Law - Isotropic Tensor
Chapter: 3</td></tr>
</table>

	Unit III Tensor in Analytic Solid Geometry**:** Vector as Directed Line Segments -Geometrical Interpretation of the Sum of two Vectors - Length and Angle between Two Vectors - Geometrical Interpretation of Scalar and Vector Products -Scalar Triple Product - Vector Triple Products - Tensor Formulation of Analytical Solid Geometry - Distance Between Two Points P(xi) and Q(yi) - Angle Between Two Lines with Direction Cosines -The Equation of Plane -Condition for Two Line Coplanar. **Chapter : 4**
	Unit IV General Tensor**:** Curvilinear Coordinates - Coordinate Transformation Equation - Contravariant and Covariant Tensor - Contravariant Vector or Contravariant Tensor of Order-One - Covariant Vector or Covariant Tensor of Order-One - Mixed Second-Order Tensor - General Tensor of Any Order - Metric Tensor - Associate Contravariant Metric Tensor - Associate Metric Tensor - Christoffel Symbols of the First and Second Kind- Covariant Derivative of a Covariant Vector - Covariant Derivative of a Contravariant Vector . **Chapter: 5**
	Unit V Tensor in Relativity - Special Theory of Relativity - Four-Vectors in Relativity - Maxwell's Equations - General Theory of Relativity - Spherically Symmetrical Metric- Planetary Motion ; Geodesics and Its Coordinate - Families of Curves - Euler's Form- Geodesics - Geodesic Form of the Line Elements - Geodesic Coordinate. **Chapter: 6 and 7**
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 Class hour)
Skills acquired from this course	Knowledge, Problem Solving

Recommended Text	AN INTRODUCTION TO TENSOR ANALYSIS, Dr. Bipin Singh Koranga and Dr. Sanjay Kumar Padaliya, *Published, sold and distributed by* River Publishers-Alsbjergvej 10. 9260 Gistrup , Denmark.
Reference Books	1. Harold Jeeffreys (1931), Cartesian Tensors, PP(1-16), Cambridge University Press(New York) 2. David C. Kay, Theory and Problem of Tensors Calculus, PP(1-3). McGraw Hill, Washinton, D.C. 3. Shanti Narayan (1961), Cartesian Tensors, PP(1-12), S.chand, New Delhi. 4. DE Bourine and PC Kendell (1967), Vector Analysis and Cartesian Tensor, PP(245-257), Chapman &Hall. 5. Barry Spain (1960), Tensor Calculus, PP(1-55), Dover Publication, Newyork. 6. A.J. McConnell (1960), Application of Tensor Analysis, PP(1-9)Khosla Publication, New Delhi. 7. Zefer Ahson (2000), Tensor Analysis with Applications,Anamaya Publisher, New Delhi. 8.U.C. De (2008), Tensor Calculus, PP(1-9), Narosa Publishing House, New Delhi.
Online reference	ISBN: 978-87-7022-581-6 (Hardback) 978-87-7022-580-9 (Ebook)

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO 1: Cartesian Tensor

CLO 2: Tensor in Physics

CLO 3: Tensor in Analytic Solid Geometry

CLO 4: General Tensor

CLO 5: Tensor in Relativity

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

Group D

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">1.Wavelets</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">ELECTIVE IV</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">ELECTIVE COURSE</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>I</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>4</td><td colspan="2">1</td><td colspan="2">--</td><td colspan="2">5</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="8">Basic knowledge knowledge in series and function.</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="8">To understand the Wavelet transform, Scaling functions and Wavelet Series in L_p Spaces.</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="8">Unit I: Introduction to Wavelets, Motivation and Heuristics, Wavelet Transform, Haar Functions and Haar Series, Haar Sums and Dyadic Projections, Haar Series in C_0 and L_p Spaces, Pointwise Convergence of Haar Series.
Chapter 6 - 6.1, 6.2, 6.3 - 6.3.1 to 6.3.3</td></tr>
<tr><td colspan="8">Unit II: Multiresolution Analysis, Orthonormal Systems and Riesz Systems, Scaling Equations and Structure Constants, From Scaling Function to MRA, Meyer Wavelets.
Chapter 6 - 6.4.1 to 6.4.3</td></tr>
<tr><td colspan="8">Unit III: 3 From Scaling Function to Orthonormal Wavelet, Direct Proof that $V_1 \ominus V_0$ is spanned by $\{\psi(t-k)\}_{k\in\mathbb{Z}}$, Null Integrability of Wavelets without Scaling Functions.
Chapter 6 - 6.4.5</td></tr>
<tr><td colspan="8">Unit IV: Wavelets with Compact Support, From Scaling Filter to Scaling Function, Explicit Construction of Compact Wavelets, Smoothness of Wavelets, Cohen's Extension Theorem.
Chapter 6 - 6.5.</td></tr>
<tr><td colspan="8">Unit V: Convergence Properties of Wavelets Expansions, Wavelet Series in L_p Spaces, Jackson's and Bernstein's Approximation Theorems.
Chapter 6 - 6.6</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 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	Mark A. Pinsky: Introduction to Fourier Analysis and Wavelets, Cenage Learning India Pvt. Ltd, 2009.
Reference Books	1. C. Sidney Burrus, Ramesh A. Gopinath, Haitao Guo: Introduction to Wavelets and Wavelet Transforms, Prentice Hall Upper Saddle River, New Jersey 07458. 2. Jonas Gomes Luiz Velho: From Fourier Analysis to Wavelets, Springer, 2015. 3. M.V. Altaisky: Wavelets Theory, Applications Implementation, University Press, 2009. 4. K.P. Soman, K.I. Ramachandran, N.G. Resmi: Insight into Waveletes from Theory to Practice, Third Edition.
Website and e-Learning Source	-

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO 1: Understand Wavelets and to make use of the tools of Fourier Analysis.

CLO 2: Characterize the smoothness of functions using wavelets.

CLO 3: Understand Haar Wavelet Exapansions and to construct general wavelets.

CLO 4: Develop a systematic method to produce orthonormal wavelets.

CLO 5: Understand scaling functions along with convergence properties and speed of convergence.

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

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">2.Modelling and Simulation with Excel</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">ELECTIVE IV</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">ELECTIVE COURSE</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>I</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>4</td><td colspan="2">1</td><td colspan="2">--</td><td colspan="2">5</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="8">Basic Skills in computers</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="8">To understand modelling and simulation with the help of Excel.</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="8">Unit I: Modelling and Simulation: Introduction Model, Classifications of Models, An Example of Deterministic Modelling, A Preliminary Analysis of the Event, Understanding the Important Elements of a Model, Pre-Modelling or Design Phase, Modelling Phase.</td></tr>
<tr><td colspan="8">Unit II: Resolution of Weather and Related Attendance, Attendees Play Games of Chance, OLPS Modelling Effort, Model Building with Excel, Basic Model, Sensitivity Analysis, Controls from the Forms Control Tools, Option Buttons, Scroll Bars.</td></tr>
<tr><td colspan="8">Unit III:Types of Simulation and Uncertainty, Incorporating Uncertain Processes in Models, The Monte Carlo Sampling Methodology, Implementing Monte Carlo Simulation Methods.</td></tr>
<tr><td colspan="8">Unit IV:Modelling Arrivals with the Poisson Distribution, VLOOKUP and HLOOKUP Functions, A Financial Example– Income Statement, An Operations Example–Autohaus, Status of Autohaus Model.</td></tr>
<tr><td colspan="8">Unit V: Building the Brain Worksheet, Building the Calculation Worksheet, Variation in Approaches to Poisson Arrivals: Consideration of Modelling Accuracy, Sufficient Sample Size, Building the Data Collection Worksheet, Results.</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 NET / UGC – CSIR / GATE / TNPSC / others to be solved
(To be discussed during the Tutorial hour)</td></tr>
</table>

Skills acquired from this course	Ability to create and write new models.
Recommended Text	Hector Guerrero, Excel Data Analysis Modelling and Simulation, Second Edition, Springer.
Reference Books	1. Cliff T. Ragsdale, Spreadsheet Modelling and Decision Analysis, Ninth Edition. 2. **John** A. **Sokolowski**, Catherine M. Banks, Modelling and Simulation Fundamentals, A John Wiley & Sons, Inc. Publication, 2010.
Website and e-Learning Source	-

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO 1: Understand a model's structure, its capabilities, and its underlying assumptions.

CLO 2: Deal models in various forms and to understand the visual models of the behaviour of a system.

CLO 3: Perform data analysis on both quantitative and qualitative data leading to models of general and specific behaviour.

CLO 4: Understand the critical role of Excel in the early or rapid prototyping of problems

CLO 5: Construct a useful and thoroughly conceived simulation model

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

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="7">3.Machine Learning and Artificial Intelligence</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="7">ELECTIVE IV</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">ELECTIVE COURSE</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>I</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td>4</td><td colspan="2">1</td><td colspan="2">--</td><td>5</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="7">Basic Skills in machines.</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="7">To get artificial intelligence with the help of machines.</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="7">Unit I:AI Foundations, Alan Turing and the Turing Test, Strong AI, Weak AI, Golden Age of AI, Technological Drivers of Modern AI, Structure of AI.</td></tr>
<tr><td colspan="7">Unit II: Data - The Fuel for AI, Data Basics, Types of Data, Big Data, Volume, Variety and Velocity of Data, Databases and Other Tools, Data Process, Business Understanding, Data Understanding, Data Preparation, Ethics and Governance, How Much Data Do You Need for AI?, More Data Terms and Concepts.</td></tr>
<tr><td colspan="7">Unit III: Machine Learning - Mining Insights from Data, What Can You Do with Machine Learning?, The Machine Learning Process - Data Order, Choose a Model, Train the Model, Evaluate the Model, Fine-Tune the Model, Applying Algorithms, Supervised Learning, Unsupervised Learning, Reinforcement Learning, Semi-supervised Learning.</td></tr>
<tr><td colspan="7">Unit IV: Common Types of Machine Learning Algorithms, General Framework for Machine Learning Algorithms, Naïve Bayes Classifier, K-Nearest Neighbour, Linear Regression, Decision Tree, Ensemble Modelling, K-Means Clustering.</td></tr>
<tr><td colspan="7">Unit V: Deep Learning - Difference Between Deep Learning and Machine Learning, What is Deep Learning, The Brain and Deep Learning, Artificial Neural Networks, Back Propagation, The Various Neural Networks - RNN, CNN, GANs, Deep Learning Applications.</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="7">Questions related to the above topics, from various competitive examinations 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="7">Getting knowledge in artificial intelligence using Machines.</td></tr>
</table>

Recommended Text	Tom Taulli, Artificial Intelligence Basics: A Non-Technical Introduction, Apress
Reference Books	1. Dan W. Patterson, Introduction to Artificial Intelligence and Expert Systems, Pearson Education, 2007. 2. Kevin Night, Elaine Rich, and Nair B., Artificial Intelligence, McGraw Hill, 2008. 3. Tom Mitchell, Machine Learning, McGraw Hill, 3rd Edition,1997. 4. Charu C. Aggarwal, Data Classification Algorithms and Applications, CRC Press, 2014.
Website and e-Learning Source	-

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO 1: Understand the AI Foundations.

CLO 2: Deal with Data.

CLO 3: Work with Data in an AI project.

CLO 4: Construct Machine Learning Algorithms.

CLO 5: Understand Deep learning.

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

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">4.Neural Networks</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">ELECTIVE IV</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">ELECTIVE COURSE</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>I</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>4</td><td colspan="2">1</td><td colspan="2">--</td><td colspan="2">5</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="8">Basic skills in networks.</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="8">To get artificial intelligence with the help of networks.</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="8">Unit I: Basics of Artificial Neural Networks, Characteristics of Neural Networks, Historical Development of Neural Network Principles.
Chapters 1</td></tr>
<tr><td colspan="8">Unit II: Artificial Neural Networks: Terminology, Models of Neuron, Topology, Basic Learning Laws, Activation and Synaptic Dynamics, Activation Dynamics Models.
Chapters 2</td></tr>
<tr><td colspan="8">Unit III:Synaptic Dynamics Models, Learning Methods, Stability and Convergence. Functional Units of ANN for Pattern Recognition Tasks, Pattern Recognition Problem.
Chapters 3</td></tr>
<tr><td colspan="8">Unit IV:Basic Functional Units, Pattern Recognition Tasks by the Functional, Feedforward Neural Networks, Analysis of Pattern Association Networks, Analysis of Pattern Classification Networks.
Chapters 4-4.1 to 4.3</td></tr>
<tr><td colspan="8">Unit V: Feedback Neural Networks, Analysis of Linear Autoassociative FF Networks, Analysis of Pattern Storage Networks.
Chapters 5-5.1 to 5.3</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 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">Getting knowledge in artificial intelligence using Networks.</td></tr>
</table>

Recommended Text	: R. Yegnanarayana, Artificial Neural Networks, Prentice Hall of India, 2005, 2, 3,
Reference Books	1. Charu C. Aggarwal, Neural Networks and Deep Learning, Springer 2. Adam Gibson and Josh Patterson, Deep Learning: A Practioner's Approach, First Edition
Website and e-Learning Source	-

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO 1: Understand the Basics of Artificial Neural Networks.

CLO 2: Understand the Basic Learning Laws and Activation Dynamic Models.

CLO 3: Deal with Pattern Recognition Problems.

CLO 4: Analyze Feedforward Neural Networks, Pattern Association Networks and Pattern Classification Networks.

CLO 5: Deal with Feedback Neural Networks, Linear Autoassociative FF Networks and Analysis of Pattern Storage Networks.

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

Group E

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">1.ALGEBRAIC NUMBER THEORY</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">ELECTIVE V</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>III</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td>4</td><td colspan="2">1</td><td colspan="2">--</td><td>5</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">UG level Modern Algebra</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">The course aims to provide a study on modules over rings, finite fields, algebraic extensions, number fields and cyclotomic fields, Noetherian rings and modules and Dedekind rings</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="6">UNIT - I
Rings and Fields- Factorization of Polynomials - Field Extensions – Symmetric Polynomials - Modules - Free Abelian Groups
Chapter 1: Sec. 1.1 to 1.6</td></tr>
<tr><td colspan="6">UNIT - II
Algebraic numbers - Conjugates and Discriminants - Algebraic Integers – Integral Bases - Norms and Traces - Rings of Integers
Chapters 2: Sec. 2.1 to 2.6</td></tr>
<tr><td colspan="6">UNIT - III
Quadratic fields and cyclotomic fields - Factorization into Irreducibles - Trivial factorization - Factorization into irreducibles - Examples of non-unique factorization into irreducibles
Chapter 3: Sec. 3.1 and 3.2 Chapter 4: Sec. 4.2 to 4.4</td></tr>
<tr><td colspan="6">UNIT - IV
Prime Factorization - Euclidean Domains - Euclidean Quadratic fields – Consequences of unique factorization - The Ramanujan-Nagell Theorem
Chapter 4: Sec. 4.5 to 4.9</td></tr>
<tr><td colspan="6">UNIT - V
Prime Factorization of Ideals - The norms of an Ideal - Nonunique Factorization in Cyclotomic Fields
Chapter 5: Sec. 5.2 to 5.4</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>
</table>

Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	I. Steward and D.Tall, Algebraic Number Theory and Fermat's Last Theorem (3rd Edition) A.K.Peters Ltd., Natrick, Mass. 2002.
Reference Books	1. Z.I.Bosevic and I.R.Safarevic, Number Theory, Academic Press, New York, 1966 2. J.W.S.Cassels and A.Frohlich, Algebraic Number Theory, Academic Press, New York, 1967 3. P.Ribenboim, Algebraic Numbers, Wiley, New York, 1972 4. P. Samuel, Algebraic Theory of Numbers, Houghton Mifflin Company, Boston, 1970 5. A.Weil. Basic Number Theory, Springer, New York, 1967
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: understand the concept of Modules

CLO 2: deal with algebraic integers and its applications

CLO 3: understand the concept of Quadratic fields and cyclotomic fields

CLO 4: learn Ramanujan-Nagell Theorem

CLO 5: understand Prime Factorization of Ideals

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

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">2.FLUID DYNAMICS</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">ELECTIVE V</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>III</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td colspan="2">Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td colspan="2">4</td><td colspan="2">1</td><td colspan="2">--</td><td>5</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="8">UG Level Calculus and Vector Calculus</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="8">This course aims to discuss kinematics of fluids in motion, Equations of motion of a fluid, three dimensional flows, two dimensional flows and viscous flows.</td></tr>
<tr><td colspan="2">Course Outline</td><td colspan="8">UNIT - I
Kinematics of Fluids in motion - Real fluids and Ideal fluids - Velocity of a fluid at a point, Stream lines, path lines, steady and unsteady flows - Velocity potential – The vorticity vector- Local and particle rates of changes - Equations of continuity - Worked examples - Acceleration of a fluid - Conditions at a rigid boundary.
Chapter 2: Sections 2.1 to 2.10</td></tr>
<tr><td colspan="2"></td><td colspan="8">UNIT - II
Pressure at a point in a fluid at rest - Pressure at a point in a moving fluid - Conditions at a boundary of two inviscid immiscible fluids- Euler’s equation of motion - Discussion of the case of steady motion under conservative body forces.
Chapter 3: Sections 3.1 to 3.7</td></tr>
<tr><td colspan="2"></td><td colspan="8">UNIT - III
Some three dimensional flows – Introduction - Sources, sinks and doublets - Images in a rigid infinite plane - Axis symmetric flows - Stokes stream function.
Chapter 4: Sections 4.1, 4.2, 4.3, 4.5</td></tr>
<tr><td colspan="2"></td><td colspan="8">UNIT - IV
Meaning of two dimensional flow - Use of Cylindrical polar coordinate - The stream function - The complex potential for two dimensional, irrotational incompressible flow - Complex velocity potentials for standard two dimensional flows - Some worked examples - Two dimensional Image systems - The Milne Thompson circle Theorem.
Chapter 5: Sections 5.1 to 5.8</td></tr>
</table>

	UNIT - V Stress components in a real fluid - Relations between Cartesian components of stress - Translational motion of fluid elements - The rate of strain quadric and principal stresses - Some further properties of the rate of strain quadric - Stress analysis in fluid motion - Relation between stress and rate of strain - The coefficient of viscosity and Laminar flow - The Navier - Stokes equations of motion of a Viscous fluid. **Chapter 8**: Sections 8.1 to 8.9
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	F. Chorlton, Text Book of Fluid Dynamics, CBS Publications, Delhi, 1985
Reference Books	1. R.W.Fox and A.T.McDonald. Introduction to Fluid Mechanics, Wiley, 1985 2. E.Krause, Fluid Mechanics with Problems and Solutions, Springer, 2005 3. B.S.Massey, J.W.Smith and A.J.W.Smith, Mechanics of Fluids, Taylor and Francis, New York, 2005 4. P.Orlandi, Fluid Flow Phenomena, Kluwer, New Yor, 2002 5. T.Petrila, Basics of Fluid Mechanics and Introduction to Computational Fluid Dynamics, Springer, Berlin, 2004
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

CLO 1: Understand the basic properties and principles of viscous and non-viscous fluids

CLO 2: Derive and deduce the consequences of the governing equations of fluids

CLO 3: Solve kinematics problems such as finding particle paths and streamlines

CLO 4: Understand the basic theorems of fluid mechanics and its applications

CLO 5: Derive the boundary layer equations of some basic flows and its solutions

	POs	PSOs

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

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">3.STOCHASTIC PROCESSES</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">ELECTIVE V</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>III</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="2">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>4</td><td>1</td><td colspan="2">--</td><td colspan="2">5</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">UG level Probability Theory and Queuing Theory</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">To introduce a wide variety of stochastic processes and their applications.</td></tr>
<tr><td colspan="2" rowspan="3">Course Outline</td><td colspan="6">UNIT - I
Definition of stochastic processes – Markov chains: Definition-order of a markov chain – Higher transition probabilities – classification of states and chains.
Chapter 2: Sections 2.1 - 2.3, Chapter 3: Sections 3.1- 3.4</td></tr>
<tr><td colspan="6">UNIT – II
Markov Process with discrete state space: Poisson process and related distributions – Properties of Poisson process - Generalizations of Poisson processes – Birth and death processes – Continuous time Markov chains.
Chapter 4: Sections 4.1 - 4.5</td></tr>
<tr><td colspan="6">UNIT – III
Markov processes with continuous state space: Introduction - Brownian motion – Weiner process and differential equations for it - Kolmogrov equations – First passage time distribution for Weiner process – Ornstein – Uhlenbech process.
Chapter 5: Sections 5.1 - 5.6</td></tr>
</table>

	UNIT – IV Branching Processes: Introduction – Properties of generating functions of Branching processes – Distribution of the total number of progeny – Continuous - Time Markov branching process - Age dependent branching process: Bellman-Harris process. **Chapter 9**: Sections 9.1, 9.2, 9.4, 9.7
	UNIT – V Stochastic Processes in Queueing Systems: Concepts – Queueing model M/M1 – transient behavior of M/M/1 model – Birth and death process in Queueing theory : M/M/1 – Model related distributions – M/M/∞ - M/M/S/S – Loss system - M/M/S/M – Non birth and death Queueing process : Bulk queues – $M^{(X)}$/M/1 **Chapter 10:** Sections 10.1 - 10.5
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	J. Medhi, Stochastic Processes, 2nd Edition, New age international Private limited, New Delhi, 2006
Reference Books	1. K. Basu, Introduction to Stochastic Process, Narosa Publishing House, New Delhi, 2003 2. Goswami & B. V. Rao, A Course in Applied Stochastic Processes, Hindustan Book Agency, New Delhi, 2006 3. G. Grimmett & D. Stirzaker, Probability and Random Processes, 3rd Ed., Oxford University Press, New York, 2001
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

CLO 1: Acquire in-depth knowledge about stationary stochastic processes and Markov chains.

CLO 2: Proficient in Markov Process with discrete state space.

CLO 3: Proficient in Markov processes with continuous state space.

CLO 4: Proficient in Branching processes and age dependent branching process.

CLO 5: Proficient in solving stochastic processes in queuing systems.

	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">4.MATHEMATICAL PYTHON -I</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">ELECTIVE V</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>III</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td>4</td><td colspan="2">1</td><td colspan="2">--</td><td>5</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">Basic computer skill</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">Problem solving and programming capability</td></tr>
<tr><td colspan="2" rowspan="2">Course Outline</td><td colspan="6">UNIT – I
Features of Python - Chronology and Uses - Installation of Anaconda - Basic Data Types Revisited – Strings - Lists and Tuples - Conditional Statements: if, if…else, and if…elif…else constructs – if…elif…else Ladder - Logical Operators - The Ternary Operator - get Construct – Examples
Chapter 1: 1.2, 1.4, 1.5 Chapter 2: 2.2 to 2.4 Chapter 3: 3.2 to 3.7</td></tr>
<tr><td colspan="6">UNIT – II
Looping: While - Patterns -Nesting and Applications of Loops in Lists – Functions: Features of a Function - Basic Terminology - Definition and Invocation - Types of Function - Implementing Search – Scope - Recursion
Chapter 4: 4.2 to 4.4 Chapter 5: 5.2 to 5.8</td></tr>
</table>

	UNIT – III Iterations, Generators, and Comprehensions: Power of "For" - Iterators - Defining an Iterable Object - Generators – Comprehensions - File Handling: Introduction - File Handling Mechanism - Open Function and File Access Modes - Python Functions for File Handling - Command Line Arguments - Implementation and Illustrations **Chapter 6**: 6.2 to 6.6. Chapter 7: 7.1 to 7.6
	UNIT – IV Strings: Introduction - Use of "For" and "While" - String Operators - Functions for String Handling - Introduction to Object Oriented Paradigm: Introduction - Creating New Types - Attributes and Functions - Elements of Object-Oriented Programming **Chapte**r **8**: 8.1 to 8.4 Chapter 9: 9.1 to 9.4
	UNIT – V Classes and Objects: Introduction to Classes - Defining a Class - Creating an Object - Scope of Data Members - Nesting - Constructor - Constructor Overloading – Destructors – Inheritance: Introduction to Inheritance and Composition - Importance and Types – Methods - Search in Inheritance Tree - Class Interface and Abstract Classes **Chapter 10**: 10.1 to 10.8 Chapter 11: 11.1 to 11.5
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 / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	H.Bhasin: Python Basics, Mercury Learning and Information Dulles, Virginia Boston, Massachusetts New Delhi
Reference Books	1. Beginning-Python, Second Edition by Magnus Lie Hetland 2. The Complete Reference Python by Martin C. Brown 3. Head First Python by Patrick Barry 4. Learning Python, O'Reilly by Mark Lutz 5. Python in a Nutshell, O'Reilly by Alex Martelli
Website and e-Learning Source	https://nptel.ac.in/courses/106/106/106106212/ https://programming-steps.blogspot.com/2013/10/raptor-flowchart https://wiki.python.org/moin/BeginnersGuide/Download https://www.edx.org/learn/python

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO 1: Appreciate the importance and features of Python

CLO 2: Define and classify functions

CLO 3: Understand the use and application of iterators

CLO 4: Understand how to create a class in Python

CLO 5: Differentiate between inheritance and composition

	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

Group F

Title of the Course	**1.ALGEBRAIC GEOMETRY**					
Paper Number	**ELECTIVE VI**					
Category Elective	**Year**	II	**Credits**	3	**Course Code**	
	Semester	IV				
Instructional Hours per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
	4	1	--	5		
Pre-requisite	UG level abstract algebra and point-set topology					
Objectives of the Course	To study geometric problems of higher complexity than other nearby fields.					

Course Outline	**UNIT-I :** AFFINE AND PROJECTIVE VARIETIES: Noetherian rings and modules-Emmy Noether's theorem and Hilbert's Basissatz-Hilbert's Nullstellensatz-Affine and Projective algebraic sets- Krull's Hauptidealsatz-topological irreducibility,Noetherian decomposition- local ring, function field,transcendencedegreeanddimensiontheory-Quasi-CompactnessandHausdorffness-Prime and maximal spectra- Example: linear varieties, hypersurfaces, curves.
	UNIT-II : MORPHISMS:Morphismsinthecategoryofcommutativealgebrasoveracommutativering-behaviour under localization-morphisms of local rings- tensor products- Product varieties- standard embeddings like the segre- and the d-uple embedding.
	UNIT-III : RATIONALMAPS:Relevancetofunctionfieldsandbirationalclassification-Example: classification of curves-blowing-up.
	UNIT-IV : NONSINGULAR VARIETIES: Nonsingularity- Jacobian Criterion-singular locus- Regular localrings-Normalrings-normalvarieties-Normalization-conceptofdesingularisationandits relevancetoClassificationProblems-JacobianConjecture-relationshipsbetweenaringandits completion- nonsingular curves.
	UNIT-V: INTERSECTIONSINPROJECTIVESPACE:Notionsofmultiplicityandintersectionwith examples.
Extended professional Component (is a part ofinternal 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. RobinHartshorne,AlgebraicGeometry,GraduateTextsinMathematics(GTM)Vol.52,Corr. 8th Printing, 1997, Springer-Verlag . 2. C.Musili,AlgebraicGeometryforBeginners,TextsandReadingsin Mathematics20, Hindustan Book Agency, India, 2001
Reference Books	1. David Dummit & Richard Foote, Abstract Algebra, Wiley, 2011. 2. M. Atiyah, I.Macdonald, Commutative algebra, Hachette UK, 1994. 3. D. Eisenbud, Commutative algebra, with a view toward algebraic geometry, 2013. 4**.** Algebraic geometry : a first course J. Harris, Springer, 1995. 5.Algebraic Geometry, J.S.Milnev6.02 (March 19, 2017).
Website and e-Learning Source	**www.jmilne.org/math** **https://williamtroiani.github.io/pdfs/HartshorneSolutions.pdf**

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO1: Analyze and evaluate Affine and Projective algebraic sets.
CLO2: Describe the concept of Morphism integral and standard embeddings
CLO3: Demonstrate the concept Rational Maps.
CLO4: Construct Jacobian Criterian and Jacobian Conjecture
CLO5: Formulate the Intersections in projective space.

	Pos						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CLO1	3	1	3	2	3	3	3	2	1
CLO2	2	1	3	1	3	3	3	2	1
CLO3	3	2	3	1	3	3	3	2	1
CLO4	1	2	3	2	3	3	3	2	1
CLO5	3	1	2	3	3	3	3	2	1

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">2.FINANCIAL MATHEMATICS</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">ELECTIVE VI</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>IV</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td colspan="2">Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td colspan="2">4</td><td colspan="2">1</td><td colspan="2">--</td><td>5</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="8">UG Level Mathematical Statistics and Stochastic Model</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="8">To impart the knowledge of active and practical use of mathematics which includes stochastic integrals, binomial model, Black-Scholes Models and the Multi dimensional Black Scholes models.</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="8">UNIT-I :
Brownian Motion-Stochastic Integrals-Ito process-Ito formula-Grisanov Transformation and martingale representation theorem</td></tr>
<tr><td colspan="8">UNIT-II :
Financial Markets-derivatives-Binomial Models-Pricing European and American Contingent claim</td></tr>
<tr><td colspan="8">UNIT-III :
Definition of the finite market model-first and second fundamental theorems of asset pricing-pricing European contingent claims-incomplete markets-separating hyperplane theorems</td></tr>
<tr><td colspan="8">UNIT-IV :
Black-Scholes models-Equivalent martingale measure- European contingent claims- pricing European contingent claims-European Call options-Black Scholes formula-American Contingent claims-American call and put options</td></tr>
<tr><td colspan="8">UNIT-V:
Multi-dimensional Black-Scholes model- first and second fundamental theorems of asset pricing-form of equivalent local martingale measures-pricing European contingent claims and incomplete markets.</td></tr>
</table>

Extended professional Component (is a part ofinternal 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.J.Williams, Introduction to Mathematics of Finance, American Mathematical Society,2006
Reference Books	1.Steaphen Garrett, An introduction of Mathematics of Finance: A Deterministic approach, Butterworth-Heinemann Ltd; 2nd Revised edition,2013 2. S.M.Ross, An elementary introduction to Mathematical Finance,Cambridge University Press,3rd edition,2011 3. MarekCapinski, Tomasz Zastawniak,Mathematics for Finance:An introduction to Financial Engineering Springer,2nd edition 2011 4. .M.Ross,"AppliedProbabilitymodelswithOptimizationApplications" ,Holdenday, 1980.
Website and e-Learning Source	**https://onlinecourses.nptel.ac.in/noc19_ma26/preview** **https://corporatefinanceinstitute.com/resources/data-science/financial-mathematics/**

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO1: Analyze Brownian motion and evaluate stochastic integrals

CLO2: Describe the concept Financial market

CLO3: Demonstrate the finite market model and incomplete markets.

CLO4: Construct Balck Scholes model

CLO5: Formulate the Multi-dimensional Black Scholes model

	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
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	**3.RESOURCE MANAGEMENT TECHNIQUES**						
Paper Number	**ELECTIVE VI**						
Category Elective	**Year**	II	**Credits**	3	**Course Code**		
	Semester	IV					
Instructional Hours per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**			
	4	1	--	5			
Pre-requisite	UG Level Operation Research						
Objectives of the Course	To study about the networking models and the game theory with its solving methods						
Course Outline	**UNIT-I :** Network models-Minimal spanning tree algorithm-shortest route algorithms-critical path calculation-tree and total floats **Chapter 6:** 6.1 to 6.3,6.5						
	UNIT-II *:* Advanced Linear Programming, simplex method using the restricted basis-revised simplex method **Chapter 7:** 7.1, 7.2						
	UNIT-III : Game theory-Optimal solution of two-person zero sum games-solution of mixed strategy games-linear programming solution of games **Chapter 13:** 13.4						
	UNIT-IV : Classical Optimization theory-Jacobian method - Lagrangian method-The Newton Raphson-Karush-Kuhn-Tucker conditions **Chapter 18:** 18.1 to 18.2						

	UNIT-V: Nonlinear Programming Algorithms-separable programming-quadratic programming **Chapter 19:** 19.1,19.2.1, 19.2.2
Extended professional Component (is a part ofinternal 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 and familiar with linear and non-linear programming
Recommended Text	H.A.Taha, Operations Research 8th edition, Prentice Hall, New Delhi,1998
Reference Books	1.F.S.Hiller and G.J.Lieberman; An introduction to operations research, Holden-Day, Inc.San Fransisco, 1973 2.L.Cooper and D.Steiberg, Introduction to methods of optimization, W.B.Saunders company, Philedelphia, 1970
Website and e-Learning Source	**https://www.classcentral.com/course/swayam-operations-research-14219** **https://developers.google.com/optimization/support/resources**

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO1: Analyze Critical Path Calculation
CLO2: Describe the simplex method using the restricted basis
CLO3: Demonstrate the Two person zero-sum game and finding the optimal solutions
CLO4: Construct Karush-Kuhn-Tucker conditions
CLO5: Formulate the Non-linear programming

	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CLO1	3	1	3	2	3	3	3	2	1
CLO2	2	1	3	1	3	3	3	2	1
CLO3	3	2	3	1	3	3	3	2	1
CLO4	1	2	3	2	3	3	3	2	1

CLO5	3	1	2	3	3	3	3	2	1

Title of the Course	**4.MATHEMATICAL PYTHON -II**						
Paper Number	**ELECTIVE VI**						
Category Elective	**Year**	II	**Credits**	3	**Course Code**		
	Semester	IV					
Instructional Hours per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**			
	4	1	--	5			
Pre-requisite	Basic Computer Skill						
Objectives of the Course	Problem solving and Programming capability						
Course Outline	**UNIT-I :**OPERATOR OVERLOADING Methods for Overloading Binary Operators - Overloading Binary Operators: The Fraction Example- Overloading the + = Operator - Overloading the > and < Operators -Overloading the _boolEan_ Operators: Precedence of _bool_over _len_ **Chapter 12:**12.3 to 12.7						
	UNIT-II : EXCEPTION HANDLING Importance and Mechanism - Built-In Exceptions in Python-The Process **Chapter 13:** 13.2 to 13.4						
	UNIT-III : NUMPY Introduction to NumPy and Creation of a Basic Array –Functions for generating sequences-Aggregate Functions **Chapter 18:** 18.2 to 18.4						
	UNIT-IV : MATPLOTLIB The Plot Function-Subplots -3 Dimensional Plotting **Chapter 19:** 19.2 to 19.4						
	UNIT-V: IMAGE PROCESSING Opening, Reading, and Writing an Image - The Contour Function-Clipping **Chapter 20:** 20.2 to 20.4						

Extended professional Component (is a part ofinternal 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, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	H.Bhasin: Python Basics, Mercury Learning and Information Dulles, Virginia Boston, Massachusetts ,New Delhi
Reference Books	1.Beginning-Python, Second Edition by Magnus Lie Hetland 2. The Complete Reference Python by Martin C. Brown 3. Head First Python by Patrick Barry 4. Learning Python, O"Reilly by Mark Lutz 5. Python in a Nutshell, O"Reilly by Alex Martelli
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: Implement operator overloading for complex numbers and fractions

CLO2: Use try/except and manually throw exceptions

CLO3: Create uni-dimensional and multi-dimensional arrays

CLO4: Create three dimensional plots using MATPLOTLIB

CLO5: Understand the concept of clipping

	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
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

Skill Enhancement Courses (SEC)

Group G

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">1.COMPUTATIONAL MATHEMATICS USING SageMath</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">SEC I</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">SEC</td><td>Year</td><td></td><td rowspan="2">Credits</td><td rowspan="2">2</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td></td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td>Tutorial</td><td>Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>1</td><td>-</td><td>2</td><td colspan="2">3</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">Basic Computer Skill</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">Problem solving and Programming capability</td></tr>
<tr><td colspan="2" rowspan="3">Course Outline</td><td colspan="6">UNIT-I :Sage as a Calculator:
Elementary functions and Usual Constants-Online help and Automatic Completion-Python variables-Symbolic variables –First Graphics
Chapter 1: 1.2.2 to 1.2.6</td></tr>
<tr><td colspan="6">UNIT-II : Expressions and Simplifications:
Symbolic Expressions-Transforming Expressions-Usual Mathematical Expressions-Assumptions-Some Pitfalls –Explicit Solving-Equations with no explicit solution
Chapter 2: 2.1.1 to 2.1.5 and 2.2.1 to 2.2.2</td></tr>
<tr><td colspan="6">UNIT-III : Analysis
Sums-Limits-Sequences- Power Series Expansions-Series-Derivatives-Partial Derivatives-Integrals
Chapter 2: 2.3.1 to 2.3.8</td></tr>
</table>

	UNIT-IV : Basic Linear Algebra Solving Linear Systems-Vector Computations-Matrix Computations-Reduction of a Square Matrix **Chapter 2:** 2.4.1 to 2.4.4
	UNIT-V: Graphics Graphical Representation of a Function-Parametric Curve-Curve in Polar Coordinates-Curve defined by an Implicit equations-Data Plot-Displaying solutions of Differential Equations-3D curves **Chapter 4:** 4.1.1 to 4.1.1.6 and 4.2
Extended professional Component (is a part ofinternal 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	Computational Mathematics with SageMath by Paul Zimmermann and others ;
Reference Books	1.Gregory V. Bard ; Sage for Undergraduates(online version) 2.Craig Finch; Sage Biginner's Guide; PACKT Publishing(Open Source)
Website and e-Learning Source	1.https://onlinecourses.nptel.ac.in/noc21_ma29/preview 2.https://mosullivan.sdsu.edu/Teaching/sdsu-sage-tutorial/sageprog.html

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO1: Deal with Symbolic Variables
CLO2: Describe the symbolic expressions and some Pitfalls
CLO3: Demonstrates the analysis concepts
CLO4: Solve the simultaneous equations
CLO5: Displaying the solutions of Differential Equations

	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PS01	PS02	PSO3

CLO1	3	1	3	2	3	3	3	2	1
CLO2	2	1	3	1	3	3	3	2	1
CLO3	3	2	3	1	3	3	3	2	1
CLO4	1	2	3	2	3	3	3	2	1
CLO5	3	1	2	3	3	3	3	2	1

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">2.MATHEMATICAL DOCUMENTATION USING LATEX</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">SEC II</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">SEC</td><td>Year</td><td></td><td rowspan="2">Credits</td><td rowspan="2">2</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td></td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>1</td><td colspan="2">--</td><td colspan="2">2</td><td colspan="2">3</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="8">Basic Skills in computers</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="8">To introduce students with a software that is used for typesetting especially in Mathematics and develop typing skill for students with various documents formats of LaTeX.</td></tr>
<tr><td colspan="2" rowspan="4">Course Outline</td><td colspan="8">UNIT-I : Typing a very short “article” – Typing Math- Formula gallery – Typing equations and aligned formulas- The anatomy of an article – Article templates
Chapter 1: 1.1 to 1.6.</td></tr>
<tr><td colspan="8">UNIT-II: Your first article – LATEX error Messages – Logical & Visual design- A brief over view – Using LATEX- What’s next?
Chapter 1: 1.7 to 1.12.</td></tr>
<tr><td colspan="8">UNIT-III : Typing Text : The Keyboard- Words, sentences & paragraphs- Instructing LATEX – Symbols not on the keyboard – Commenting Out- Changing font characteristics
Chapter 2: 2.1 to 2.6.</td></tr>
<tr><td colspan="8">UNIT-IV : Lines, paragraphs and pages, Spaces, Boxes, Foot notes, Splitting up the file
Chapter 2: 2.7 and 2.11.</td></tr>
</table>

	UNIT-V: Text environments: List environments – Tabbing environment – Miscellaneous displayed text environments- Proclamations – Proof environment- Some general rules for displayed text environment – Tabular environments – Style & Size environments **Chapter 3:** 3.1 to 3.8.
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Type their own Mathematical article
Skills acquired from this course	Efficiently writing documents
Recommended Text	Math into Latex : An Introduction to Latex and AMS Latex George Grazer ISBN 0-8176-3805-9. © Birkhauser Boston 1996.
Reference Books	1.A document preparation system LATEX, Second Edition, Leslie Lamport 2. LATEX- A Beginner Guide to Professional documentation, S. Swapna Kumar.
Website and e-Learning Source	https://services.math.duke.edu/computing/tex/online.html, https://www.overleaf.com/learn

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO 1: know how to create basic types of LaTex documents (article).

CLO 2: typeset latex commands.

CLO 3: create a paragraph, symbols, comments and font style.

CLO 4: change font characteristics.

CLO 5: know about various environments.

	POs	**PSOs**

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

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">3.Office Automation and ICT Tools</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">SEC III</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">SEC</td><td>Year</td><td></td><td rowspan="2">Credits</td><td rowspan="2">2</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td></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>1</td><td colspan="2">--</td><td>2</td><td colspan="2">3</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">Basics of Computer</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">Enable the students to study MS Office and enrich the knowledge in Information Communication Technology (ICT)</td></tr>
<tr><td colspan="2" rowspan="2">Course Outline</td><td colspan="6">UNIT – I
Classification of Computers - Basic Computer Organisation - Types of Computer Software – Evolution of Internet - Basic Internet Terminologies - Getting Connected to Internet Applications - Application Software Packages - Introduction to Office Packages
Chapter 2: 1.7, 1.8, 2.3, 2.9 to 2.11, 3.5, 3.6 in Text book 1.</td></tr>
<tr><td colspan="6">UNIT – II
MS Word: Understanding Your Formatting Options - Changing Paragraph Formatting - Using Bullets, Numbering, and Multilevel Lists - Printing Word Documents – Using Tables to Organize Information - Adding and Organizing Figures and Graphics - Using Headers and Footers - Adding Lines, Borders, Shading, and Backgrounds - Keeping Long Documents Under Control - Tools for Academic and Professional Documents - Creating and Editing Letters - Creating Envelopes and Labels - Using Mail Merge to Personalize Letters and Envelopes
Chapter 13, 15, 16, 17 in Text book 2.</td></tr>
</table>

	UNIT – III MS Excel: Working with Worksheets and Workbooks - Finding, Replacing, and Transforming Data - Customizing the Worksheet Window - Printing Worksheets - Entering Data in an Excel Worksheet - Changing Formatting for a Cell or Range - Designing and Formatting a Worksheet for Maximum Readability - Entering and Editing Formulas - Finding the Right Function **Chapter**: 18, 19, 20 in Text book 2.
	UNIT – IV MS Excel (Continued): Defining a Range as a Table - Sorting and Filtering Data in a Table - Importing and Exporting Data - Building an Excel Chart - Labeling a Chart's Elements - Customizing Axes - Customizing a Chart's Appearance **Chapter**: 21, 22 in Text book 2.
	UNIT – V MS PowerPoint: Creating a Presentation - Editing the Presentation Outline - Changing a Slide Layout - Editing Slides - Viewing a Presentation - Managing Slide Shows - Organizing Formats with Master Slides - Applying and Modifying Themes - Using Transitions to Control Pacing - Animating Text and Objects on a Slide - Adding Music, Sounds and Video to Your Presentation - Planning Your Presentation - Running a Slideshow - Creating Presentations for the Web **Chapter**: 23 to 26 in Text book 2.
Extended Professional Component	Online Presentation and attending online interview using ICT tools.
Skills acquired from this course	Knowledge, Professional Communication and Transferrable Skill
Recommended Text	1. E Balagurusamy, Fundamentals of Computing and Programming, Second Edition, Tata McGraw Hill Education Private Limited, New Delhi 2. Ed Bott, Woody Leonhard, Using Microsoft Office 2007, Pearson Education , 2007
Reference Books	1. Cloria Madumere, 3 – IN – 1 Microsoft Word, Powerpoint and Excel 2010, First Edition 2016, Create space Independent Publishing Platform Education Pvt. Ltd. 2. Ron Mansfield, Working in Microsoft Office, Tata McGraw Hill
Website and e-Learning Source	https://nptel.ac.in/courses/ https://www.coursera.org/

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO 1:Perform basic editing functions, formatting text, copy and moving objects and text.

CLO 2: Learn the formatting skills on paragraphs, tables, lists, and pages.

CLO 3: Handle data in Excel spreadsheet.

CLO 4: Understand the need and use of using Excel templates.

CLO 5: Learn to modify presentation themes, formatting techniques and presentation styles.

	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">4.Numerical analysis using Python</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">SEC IV</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">SEC</td><td>Year</td><td></td><td rowspan="2">Credits</td><td rowspan="2">2</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td></td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td>Tutorial</td><td>Lab Practice</td><td colspan="3">Total</td></tr>
<tr><td></td><td></td><td></td><td colspan="3"></td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">UG level Mathematics</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">To introduce the concepts and to develop working knowledge on the numerical methods for Mathematical concepts such as differentiation, integration etc to solve these problems using Python programming language.</td></tr>
<tr><td colspan="2" rowspan="3">Course Outline</td><td colspan="6">UNIT-I :Mathematical Modeling and Applications, Applied Scientific Computing, Python Programming, Background,Series Expansions, Floating-Point Numbers, Python Number Representation, Errors, Floating-Point Arithmetic. Numerical Calculus-Introduction, Numerical Differentiation, Numerical Integration, Composite Formulas, Practical Numerical Integration, Python Functions for Numerical Calculus
Chapter 1, 2 and 3</td></tr>
<tr><td colspan="6">UNIT-II :Linear Equations-Introduction, Gauss Elimination, LU Factorization and Applications, Iterative Methods, Linear Least Squares Approximation, Eigenvalues, Python’s Linear Algebra Functions
Chapter 4</td></tr>
<tr><td colspan="6">UNIT-III :Iterative Solution of Nonlinear Equations-Introduction,The Bisection Method, Fixed Point Iteration, Newton’s Method, , The Secant Method,, Newton’s Method in Higher Dimensions, Python Functions for Equation Solving
Chapter 5</td></tr>
</table>

	UNIT-IV : Interpolation-Introduction, Lagrange Interpolation, Difference Representations, Splines, Python Interpolation Functions **Chapter 6**
	UNIT-V: Differential Equations-Introduction and Euler's Method , Runge–Kutta Methods, Multistep Methods, Systems of Differential Equations, Boundary Value Problems: Shooting Methods, Conclusions and Connections: Differential Equations,Python Functions for Ordinary Differential Equations **Chapter 7**
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Creating python functions for numerical methods and comparing with the Python libraries (To be discussed during the Tutorial hour)
Skills acquired from this course	Ability to create and write solver for numerical solutions of mathematical problems.
Recommended Text	P.R. Turner, T. Arildsen, K. Kavanagh, Applied Scientific Computing With Python, Springer International Publishing AG, part of Springer Nature, 2018
Reference Books	1.J. M. STEWART, Python for Scientists, Cambridge University Press, 2014 2. C. Hill, Learning Scientific Programming with Python, Second Edition, Cambridge University Press, 2020
Website and e-Learning Source	https://www.w3schools.com/python/python_math.asp

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO 1: Learn foundations of Python and numerical calculus of Python.

CLO 2: Learn the linear equations and study the different elimination and iterative methods and write the Python programs to solve this linear equations

CLO 3: Obtain the solutions of nonlinear equation using different iterative methods and write the Python programs to solve this nonlinear equations.

CLO 4: Define Interpolation. Methods for calculating the interpolation and write the Python programs to find the interpolation

CLO 5: Learn different numerical methods to solve ODE and systems of ODE and write the Python programs to solve ODE.

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

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">5.Differential equations using Python</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">SEC V</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">SEC</td><td>Year</td><td></td><td rowspan="2">Credits</td><td rowspan="2">2</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td></td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td></td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="8">UG level Differential equations</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="8">To introduce Python programming language and solve the ordinary and partial differential equations.</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="8">UNIT-I :A short Python tutorial,Typing Python, Objects and identifiers, Numbers, Namespaces and modules, Container objects, Python if statements, Loop constructs, Functions, Introduction to Python classes, The structure of Python, Prime numbers: a worked example
Chapter 3</td></tr>
<tr><td colspan="8">UNIT-II :One-dimensional arrays,Two-dimensional arrays,Higher-dimensional arrays, Domestic input and output, Foreign input and output, Miscellaneous ufuncs, Polynomials, Linear algebra, More numpy and beyond,Scipy,Scikits
Chapter 4</td></tr>
<tr><td colspan="8">UNIT-III :Two-dimensional graphics-Introduction, Getting started: simple figures, Cartesian plots, Polar plots, Error bars, Text and annotations, Displaying mathematical formulae, Contour plots, Compound figures, Animations, Mandelbrot sets: a worked example.Three-dimensional graphicsIntroduction, Visualization software, A three-dimensional curve, A simple surface, A parametrically defined surface, Three-dimensional visualization of a Julia set.
Chapter 5 and 6</td></tr>
<tr><td colspan="8">UNIT-IV :Ordinary differential equations, Initial value problems, Basic concepts, The odeint function, Two-point boundary value problems, Delay differential equations
Chapter 7</td></tr>
<tr><td colspan="8">UNIT-V:Partial differential equations: a pseudospectral approach, Initial-boundary value problems, Method of lines, Spatial derivatives via finite differencing, Spatial derivatives by spectral techniques for periodic problems, The IVP for spatially periodic problems, Spectral techniques for non-periodic problems, An introduction to f2py, A real-life f2py example
Chapter 8</td></tr>
</table>

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Creating python functions to solve differential equations and comparing with the Python libraries (To be discussed during the Tutorial hour)
Skills acquired from this course	Ability to create and write solver for numerical solutions of mathematical problems.
Recommended Text	J. M. STEWART, Python for Scientists, Cambridge University Press, 2014
Reference Books	1. P.R. Turner, T. Arildsen, K. Kavanagh, Applied Scientific Computing With Python, Springer International Publishing AG, part of Springer Nature, 2018 2. C.Hill, Learning Scientific Programming with Python, Second Edition, Cambridge University Press, 2020
Website and e-Learning Source	https://www.w3schools.com/python/python_math.asp

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO 1: Learn the basics of Python and write simple Python programs.

CLO 2: Learn to create the single and multi-dimensional arrays, to use the linear algebra functions available in Python and packages numpy, scipy and scikits

CLO 3: Create various types of two and three dimensional graphs using Python programs.

CLO 4: Solve the ODE, IVP, BVP and delay differential equation using Python programs

CLO 5: Solve the PDE using different methods and write the program for solving PDE.

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

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">6.Industrial Statistics with Minitab</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">SEC VI</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">SEC</td><td>Year</td><td></td><td rowspan="2">Credits</td><td rowspan="2">2</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td></td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td>Tutorial</td><td>Lab Practice</td><td colspan="3">Total</td></tr>
<tr><td>3</td><td>--</td><td>--</td><td colspan="3">3</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">Statistical Methods</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">To execute statistical methods via minitab to analyze industrial problems.</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="6">Unit I Worksheets and Projects, Data Operations, Histograms, Dotplots, Boxplots, Bar Diagrams, Pie Charts, Updating Graphs Automatically. Chapters: 1 & 2</td></tr>
<tr><td colspan="6">Unit II Pareto Charts and Cause-Effect Diagrams, Stratification, Identifying Points on a Graph, Scatterplots with Panels and Marginal Graphs, Creating an Array of Scatterplots.
Chapters 3 & 4</td></tr>
<tr><td colspan="6">Unit III Random Numbers and Numbers Following a Pattern, Sampling Random Data from a Column, Random Number Generation, Example: Solving a Problem Using Random Numbers.
Chapter 5</td></tr>
<tr><td colspan="6">Unit IV File ‘CHLORINE’, Graph of Individual Observations, Customizing the Graph, Graphs of Moving Ranges, File ‘MOTORS’, Plotting the Proportion of Defective Units, File ‘CATHETER’, File ‘FABRIC’.
Chapters 18 & 20</td></tr>
<tr><td colspan="6">Unit VMatrix Design Creation and Data Collection, Analysis of the Results, Contour Plots and Response Surface Plots, Nonparametric Analysis, Identification of the Best Model for the Data.
Chapters 28 & 29</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	Statistical methods for industrial problems along with Minitab software, Analysis of Industrial Problems using Minitab software
Recommended Text	Pere Grima Cintas, Lluıs Marco Almagro, Xavier Tort-Martorell Llabres, Industrial Statistics with Minitab, Wiley, 2012.
Reference Books	1. Shelemyah Zacks, Ron S Kennet, Modern Industrial Statistics: With Applications in R, MINITAB and JMP, Wiley, 2021. 2. Avner Friedman, Walter Littman, Industrial Mathemetics: A Course in Solving Real-World Problems, SIAM, 1994. 3. Douglas C. Montgomery, Scott M. Kowakski, Minitab Manual Design and Analysis of Experiments, Wiley, 2012.
Website and e-Learning Source	https://en.wikipedia.org/wiki/Minitab What is MiniTab? Data Analysis Tool | Simplilearn

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO 1: Understand the basics of Minitab software.

CLO 2: Use Tools and Techniques to analyze Industrial Problems.

CLO 3: Get better views of Problems.

CLO 4: Produce Visual Solutions.

CLO 5: Make use of Minitab to arrive better Decisions.

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

Ability Enhancement Courses (AEC)

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">1.Problem-Solving</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">AEC I</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">AEC</td><td>Year</td><td></td><td rowspan="2">Credits</td><td rowspan="2">2</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td></td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td>Tutorial</td><td>Lab Practice</td><td colspan="3">Total</td></tr>
<tr><td>3</td><td>--</td><td>--</td><td colspan="3">3</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">Basic ideas and definition</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">To solve the various types of problems</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="6">Unit IIntroduction and the Framework for Critical Thinking, The Framework and Tools, Clarity - Inspection
Section I : 1 to 3, Section II : 1 to 8</td></tr>
<tr><td colspan="6">Unit IIAnticipatory Thinking, The Ingredient Diagram, Vision, The Thinking Coach.
Section II : 9 to 14</td></tr>
<tr><td colspan="6">Unit IIIConclusions - Facts, Observations, Experiences, Assumptions, Credibility, Consistency.
Section III : 15 to 23</td></tr>
<tr><td colspan="6">Unit IVTriangular Thinking, Outside-the-Box Thinking, Abductive Thinking, Impossible Thinking.
Section III: 24 to 26, Section IV : 27 to 30</td></tr>
<tr><td colspan="6">Unit VDecisions - Who, Need and When, Criteria, Risk.
Section V : 31 to 34</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, Professional Communication and Transferrable Skill</td></tr>
</table>

Recommended Text	Michael Kallet, Think Smarter: Critical Thinking to Improve Problem-Solving and Decision-Making Skills, Wiley, 2014.
Reference Books	1. Nat Greene, Stop Guessing: The 9 Behaviours of Great Problem Solvers, Berrett-Koehler Publishers, 2017. 2. Sandy Pokras, Problem Solving for Teams, Crisp Fifty Minute Series, Axzo Press, 2010.
Website and e-Learning Source	-

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO 1: Able to Analyze Problems.

CLO 2: Use Tools and Techniques to think in a more effective way.
CLO 3: Get better at Problem Solving, Decision Making, and Creativity.
CLO 4: Produce Higher Quality Solutions.
CLO 5: Able to make Innovative Decisions.

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

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">2.Reaching Goals</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">AEC II</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">AEC</td><td>Year</td><td></td><td rowspan="2">Credits</td><td rowspan="2">2</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td></td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td>Tutorial</td><td>Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>3</td><td>--</td><td>--</td><td colspan="2">3</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">Current Affairs</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">To reach the achievements</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="6">Unit I Setting your Direction, Setting Individual objectives, Setting Team Objectives, Delegation, Monitoring the outcomes.
Chapter 1</td></tr>
<tr><td colspan="6">Unit IIInnovation, Success and Failure of Innovation, Execution of innovation
Chapter 2</td></tr>
<tr><td colspan="6">Unit IIIInnovation champions, Improvement, Collaboration, Learning.
Chapter 3</td></tr>
<tr><td colspan="6">Unit IVTapping into innovation, The Wellspring of innovation, Feasibility and Viability, Risks and Benefits.
Chapter 4</td></tr>
<tr><td colspan="6">Unit VActivities - Map your Vision and Targets, Conversation about Objectives, Designing System for Delegation, Business Dynamics and Innovation - Designing Organization.
Chapter 5</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>
</table>

Skills acquired from this course	Knowledge, Professional Communication and Transferrable Skill
Recommended Text	Elearn, Reaching Your Goals Through Innovation: Management Extra, Elsevier, 2007.
Reference Books	1. Jeff Olson, The Slight Edge: Turning Simple Disciplines into Massive Success and Happiness, Greenleaf Book Group Press, 2013. 2. Danielle LaPorte, The Desire Map: A Guide to Creating Goals with Soul, Sounds True, 2014.
Website and e-Learning Source	-

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO 1: Identify the objectives and to set goals.

CLO 2: Review the situation and to identify opportunities for innovation.

CLO 3: Evaluate potential quality improvements that can be made.

CLO 4: Understand the risks and benefits, feasibility, and viability of new ideas.

CLO 5: Identify their role in achieving their Goals.

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

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">3.Thinking in Systems</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">AEC III</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">AEC</td><td>Year</td><td></td><td rowspan="2">Credits</td><td rowspan="2">2</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td></td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td>Tutorial</td><td>Lab Practice</td><td colspan="3">Total</td></tr>
<tr><td>3</td><td>--</td><td>--</td><td colspan="3">3</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">Current Affairs</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">Reduce the Workers and get the more gains</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="6">Unit I The Basics, More than the Sum of Its Parts, Look Beyond the Players to the Rules of the Game, Understanding System Behaviour over.</td></tr>
<tr><td colspan="6">Unit II Time, How the System Runs Itself - Feedback, Stabilizing Loops - Balancing Feedback, Runaway Loops - Reinforcing Feedback.</td></tr>
<tr><td colspan="6">Unit III A Brief Visit to the Systems Zoo, One-Stock Systems, A System with Delays - Business Inventory, Two-Stock Systems, Renewable Stock Constrained by a Renewable Stock - a Fishing Economy.</td></tr>
<tr><td colspan="6">Unit IV Systems and Us, Why Systems Work so Well, Hierarchy, Why the Universe Is Organized into Hierarchies - a Fable, Why Systems Surprise Us.</td></tr>
<tr><td colspan="6">Unit VLinear Minds in a Nonlinear World, Non-existent Boundaries, Layers of Limits, Ubiquitous Delays, Bounded Rationality, Electric Meters in Dutch Houses, System Traps and Opportunities, Policy Resistance.</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, Professional Communication and Transferrable Skill
Recommended Text	Donella H Meadows, Thinking in Systems, Earthscan, London, 2009.
Reference Books	1. Ludwig von Bertalanffy, General System Theory: Foundations, Development, Applications, George Braziller Inc., 2015. 2. Michael C. Jackson, Critical Systems Thinking and the Management of Complexity, Wiley, 2019.
Website and e-Learning Source	-

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO 1: Understand the Structure and Behaviour Systems.

CLO 2: Understand the Layers of Hierarchical Systems.

CLO 3: Investigate Dynamical Systems.

CLO 4: Identify the Boundary of Systems and the Purpose of the Discussion.

CLO 5: Design/Redesign the System in order to achieve the Purpose.

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

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">4.Service Design</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">AEC IV</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">AEC</td><td>Year</td><td></td><td rowspan="2">Credits</td><td rowspan="2">2</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td></td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td>Tutorial</td><td>Lab Practice</td><td colspan="3">Total</td></tr>
<tr><td>3</td><td>--</td><td>--</td><td colspan="3">3</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">UG level Operations Research</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">To create new things</td></tr>
<tr><td colspan="2" rowspan="4">Course Outline</td><td colspan="6">Unit IFive Principles of Service Design Thinking, A Dynamic Language for Dynamic Approach, Connecting with People, Creating value, The Emergence of Marketing.</td></tr>
<tr><td colspan="6">Unit II Conceptual Design and Iteration, Product-service Hybrids, Graphic Design: Providing Visual Explanation, Information and Branding, Orientation and Reliability.</td></tr>
<tr><td colspan="6">Unit III Visual Control, Contribution to Service Design Process, Orientation and Style, Interaction Design: Series of Interactions.</td></tr>
<tr><td colspan="6">Unit IV Social Design: Delivering Positive Social Impact, Strategic Management, Exploring New Options, Technology, The Operations Approach, Design Ethnography.</td></tr>
</table>

	Unit V Service Design Thinking - Methods, The Iterative Process of Service Design and Thinking, Exploration, Creation, Reflection, Implementation.
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, Professional Communication and Transferrable Skill
Recommended Text	Mark Stickdorn, This is Service Design Thinking: Basics, Tools, Cases, Bis Publishers, 2012.
Reference Books	1. Lou Downe, Good Services, BIS Publishers, 2020. 2. Andy Polaine, Lavrans Løvlie, Ben Reason, Service Design: From Insight to Implemention, Rosenfeld Media, 2013.
Website and e-Learning Source	-

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO 1: Understand the Basics of Service Design.

CLO 2: Identify the Types of Service Designs.

CLO 3: Understand the Service Design Process.

CLO 4: Analyze Service Design along with Social Impact, Operations Management and Technology.

CLO 5: Understand the Iterative Process of Service Design.

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

CLO5	2	2	2	2	2	3	3	2	2

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

Title of the Course		**1.Mathematics for Life Sciences**					
Paper Number		**EDC I**					
Category	**EDC**	**Year**	II	**Credits**	3	**Course Code**	
		Semester	III				
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
Pre-requisite		+2 level Mathematics					
Objectives of the Course		To introduce the basic mathematical concepts such as sequence, vectors, matrices used in Life sciences and give some applications in life science.					
Course Outline		**UNITI :** Sequences and Discrete Difference Equations, Sequences, Limit of a Sequence, Discrete Difference Equations, Geometric and Arithmetic Sequences, Linear Difference Equation with Constant Coefficients, Introduction to Pharmacokinetics **Chapter 5**					
		UNITII : Vectors and Matrices, Vector Structure: Order Matrices Vector Algebra, Dynamics: Vectors Changing over Time **Chapter 6**					
		UNITIII : Matrix Algebra, Matrix Arithmetic, Applications **Chapter 7**					

	UNITIV : Long-Term Dynamics or Equilibrium, Notion of an Equilibrium, Eigenvectors, Stability **Chapter 8**
	UNITV: Leslie Matrix Models and Eigenvalues, Leslie Matrix Models, Long-Term Growth Rate (Eigenvalues), Long-Term Population Structure (Corresponding Eigenvectors) **Chapter 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 and the (To be discussed during the Tutorial hour)
Skills acquired from this course	Ability to model and solve the discrete biological models.
Recommended Text	E.N. Bodine, S. Lenhart, and L. J. Gross, Mathematics for the Life Sciences, Princeton University Press, 2014.
Reference Books	1. L. J. S. Allen, An Introduction to Mathematical Biology, Pearson, 2006 2. J.D. Murray, Mathematical Biology - I. An Introduction, Springer-Verlag, 2002.
Website and e-Learning Source	https://www.classcentral.com/course/swayam-biostatistics-and-mathematical-biology-13925

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO 1: Define sequence, difference equations, limit of sequence and study the difference equations.

CLO 2: Define the vectors and matrix, find the order of matrix and study the dynamics of vectors

CLO 3: Define arithmetic on matrices and applications of matrices.

CLO 4: Define Eigen values and eigen vectors and study the equilibrium and stability.

CLO 5: Develop Leslie matrix models and long term population structure of the corresponding models.

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

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">2.Mathematics for Social Sciences</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">EDC II</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">EDC</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>III</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td></td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="8">+2 level Mathematics</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="8">To introduce the mathematical concepts linear algebra calculus using social sciences.</td></tr>
<tr><td colspan="2" rowspan="5">Course Outline</td><td colspan="8">UNIT-I :Linear Algebra, Vectors and Matrices, Operations on Vectors, Matrices-Determinants, Rank of a Matrix
Chapter 1: 1.1 to 1.5</td></tr>
<tr><td colspan="8">UNIT-II :Statistical Applications of Linear Algebra, Linear Applications, Linear Algebraic Systems, Applications to Networks, Some Complements on Square Matrices
Chapter 1: 1.6 to 1.10</td></tr>
<tr><td colspan="8">UNIT-III :Differential Calculus, What’s a Function, Local Behavior and Global Behavior, What’s a Function of a Vector
Chapter 2</td></tr>
<tr><td colspan="8">UNIT-IV :Integral Calculus, Integrals and Areas, Fundamental Theorem of Integral Calculus, Antiderivative Calculus, An Immediate Application: Mean and Expected Values, Frequency/Probability Density Functions: Some Cases, People Survival
Chapter 3</td></tr>
<tr><td colspan="8">UNIT-V:Dynamic Systems-Introduction, Local Information: The Motion Law, Extracting Info from a Motion Law, Classic Approach, Numerical Approach, Qualitative Approach, A Newcomer: The Phase Diagram, Some Politically Relevant Applications
Chapter 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="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">Ability to create and analyse the mathematical models arise in social science.</td></tr>
</table>

Recommended Text	L. Peccati, M. D'Amico, M. Cigola, Maths for Social Sciences, Springer, 2018.
Reference Books	1. S. Tan, Mathematics For Management, Life And Social Sciences, Brooks/Cole, 1996 2. H. Anton, B. Kolman, Mathematics with Applications for the Management, Life, and Social Sciences, 2nd edition, Academic Press, 2014.
Website and e-Learning Source	https://www.classcentral.com/course/swayam-biostatistics-and-mathematical-biology-13925

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO 1: Define vectors and matrices and operations on vectors and matrices and calculate the rank and determinants.

CLO 2: Solve the system of linear equations and apply the matrix theory to networks and other fields

CLO 3: Define the derivative of the functions and able to analyze the local and global behaviour of the continuous functions.

CLO 4: Define integration and able to calculate the area of the continuous curve and able to calculate the expected values of continuous random variables.

CLO 5: Able to study the dynamical behaviour of the social science problems.

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

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">3.Statistics for Life and Social Sciences</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">EDC III</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">EDC</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>III</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td></td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="8">+2 level Mathematics</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="8">To introduce the basic statistical concepts and the basic statistical methods</td></tr>
<tr><td colspan="2" rowspan="2">Course Outline</td><td colspan="8">UNITI :Staistics - What and Why, Origin of Statistics, Growth of Statistics, Statistics Defined, Statistics: Science or Art, Functions of Statistics, Applications of Statistics, Limitations of Statistics, Distrust of Statistics, Statistical Methods vs Experimental Methods, Statistical Survey—An Introduction, Planning the Survey, Executing the Survey, COLLECTION OF DATA-Introduction, Primary and Secondary Data, Methods of Collecting Primary Data. SAMPLING AND SAMPLE DESIGNS-Introduction, Census and Sample Method, Theoretical Basis of Sampling, Essentials of Sampling,Methods of Sampling,Non-Probability Sampling Methods,Probability Sampling Methods,Size of Sample, Merits and Limitations of Sampling,Sampling and Non-Sampling Errors</td></tr>
<tr><td colspan="8">UNITII :Classification And Tabulation Of Data-Introduction, Meaning and Objectives of Classification, Types of Classification, Formation of Discrete and continuous Frequency Distribution, Tabulation of Data, Parts of a Table, General Rules of Tabulation, Types of Tables. Average-Defined, Types of Averages, Arithmetic Mean, Calculation of Arithmetic Mean—Continuous Series, Median, Calculation of Median—Continuous Series, Computation of Quartiles, Decides, Percentiles, Etc. Significance of Measuring Variation,Range, The Interquartile Range or the Quartile Deviation, Merits and Limitations, The Standard Deviation</td></tr>
</table>

	UNITIII : Probability - Introduction, Classical or a Priori Probability, Shortcomings of the Classical Approach, Relative Frequency Theory of Probability, Subjective Approach to Probability, Axiomatic Approach to Probability, Importance of the Concept of Probability, Calculation of Probability, Theorems of Probability, Addition Theorem, Multiplication Theorem, Conditional Probability, Bayes' Theorem, Mathematical Expectation, Random Variable and Probability Distribution, Binomial, Poisson and Normal Distributions, Hypothesis Testing - Introduction, Standard Error and Sampling Distribution, Estimation, Tests of Significance for Large Samples. Tests of Significance for Small Samples
	UNITIV : Chi-Square Test - Introduction, Chi-Square Defined, Conditions for Applying Chi-Square Test, Yates' Corrections, Uses of Chi-Square Test, Additive Property of Chi-Square, Chi-Square Test for Specified Value of Population Variance, Misuse of Chi-Square Test, Limitations on the Use of Chi-Square Test
	UNITV: The F-Test or the Variance Ratio Test, Applications of F-Test, Analysis of Variance, Analysis of Variance in Two-Way Classification Model
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Ability to collect and analyse the data using the statistical methods.
Recommended Text	S. P. Gupta, Statistical Methods, Forty Sixth Revised Edition, Sultan Chand & Sons, New Delhi, 2021.

Reference Books	**1.** Goon A.M. Gupta. A.K. and Das Gupta, B (1987). Fundamental of Statistics, vol.2 World Press Pvt. Ltd., Kolkatta **2.** G.U.Yule and M.G. Kendall (1956). An introduction to the theory of Statistics, Charles Griffin.
Website and e-Learning Source	https://alison.com/course/the-fundamentals-of-statistics?utm_source=google&utm_medium=cpc&utm_campaign=PPC_Tier-4_First-Click_Courses-_Broad_&utm_adgroup=Course-2075_The-Fundamentals-of-Statistics&gclid=CjwKCAjw6IiiBhAOEiwALNqncf9ojFI3Uc738RVoW7KdG4FiGqFXcEA4OeJQLENoFw8gUYqltWhUkRoC1QMQAvD_BwE

Course Learning Outcome (for Mapping with POs and PSOs)

Students will be able to

CLO 1: Collect the data, frame the questions and to find the sample size for their study.

CLO 2: Classify the samples and to calculate the mean, median, mode, standard deviation for discrete as well as continuous data.

CLO 3: Define the probability and random variables, some special probability distributions and do the hypothesis testing of their samples .

CLO 4:.Define Chi-square test, Yates corrections, when to use and not to use the Chi-square test.

CLO 5: Do the F-test and ANOVA for the samples.

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