

SENGUNTHAR ARTS AND SCIENCE COLLEGE

(Autonomous)

**(Affiliated to Periyar University, Salem and Approved by AICTE, NewDelhi)
An ISO 9001:2015 Certified Institutions. Recognised under section 2(f)
and 12(B)of theUGC Act,1956 and Accredited by NAAC withA⁺**

TIRUCHENGODE –637205, NAMAKKALDT.,TAMILNADU

Website: www.senguarts.edu.in Email id : info@senguarts.co.in



SYLLABUS

M.Sc.,MATHEMATICS

(CBCS –LOCF)

(With Effect From the Academic Year2024-25 onwards)

Chairman

CDC

Principal

Correspondent

INTRODUCTION

M.Sc Mathematics is a PG Degree program based on the plays a pivotal role in advancing both the theoretical foundations and practical applications of mathematics. Mathematics is not just a subject but a language that permeates every scientific discipline, from physics and engineering to economics and biology. It equips students with analytical and problem-solving skills essential for tackling complex challenges in today's data-driven world. In our Postgraduate Mathematics program, we emphasize a deep understanding of advanced mathematical theories while fostering research and innovation. The curriculum is designed to balance pure and applied mathematics, providing students with the opportunity to explore topics such as algebra, analysis, differential equations, and mathematical modelling. Our department is committed to creating an intellectually stimulating environment, supported by a distinguished faculty. Through seminars, workshops, and collaborative projects, students will engage with contemporary mathematical problems, preparing them for careers in academia, industry, and beyond. We aim to nurture a new generation of mathematicians who will lead and inspire through their expertise and creativity.

AIM

The syllabus of this program is aimed at preparing the students with the latest developments and put them on the right track to fulfill the present requirements.

ELIGIBILITY

Candidates for admission to the first year of Master of Degree in Mathematics Course shall be required to have passed the Bachelor of Science in Mathematics Degree in (Academic) conducted by the Government of Tamil Nadu.

LEARNING OUTCOMES BASED CURRICULUM FRAMEWORK GUIDELINES BASED REGULATIONS FOR POST GRADUATE PROGRAMME	
Programme:	M.Sc., MATHEMATICS
Programme Code:	24PMA
Duration:	2 years [PG]
Programme Outcomes:	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.
Programme Specific Outcomes (PSOs)	PSO 1 : To prepare the students who will demonstrate respectful engagement with other's ideas, behaviours, beliefs and apply diverse frames of references to decisions and actions. PSO 2 : To create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate start-ups and high potential organizations. PSO3 : Design and implement HR systems and 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		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CLO1	3	3	3	3	3	3	3	3	3
CLO2	3	3	3	3	3	3	3	3	3
CLO3	3	3	3	3	3	3	3	3	3
CLO4	3	3	3	3	3	3	3	3	3
CLO5	3	3	3	3	3	3	3	3	3
Weightage	15	15	15	15	15	15	15	15	15
Weighted Percentage	3	3	3	3	3	3	3	3	3

Level of Correlation between POs and PSOs :

(Suggested by UGC as per Six SigmaTool – Cause and Effect Matrix);

1 – Low, 2 – Medium, 3 – High, 0 – No Correlation

I YEAR

S.No	CourseCategory	Coursecode	Titleofthecourse	Hrs/Week			Credit Points	MaxMarks		
				L	T	P		CIA	ESE	Total
SEMESTER I										
1	PART A CORE I	24S1PMA01	Algebraic Structures	7	-	-	5	25	75	100
2	PART A CORE II	24S1PMA02	RealAnalysis–I	7	-	-	5	25	75	100
3	PART A CORE III	24S1PMA03	OrdinaryDifferentialEqua tion	6	-	-	4	25	75	100
4	PART A ELECTIVE I		Choose any one paper from Group A	5	-	-	3	25	75	100
5	PART A ELECTIVE II		Choose anyone paper from Group B	5	-	-	3	25	75	100
Total				30			20			500
SEMESTER II										
1	PART A CORE IV	24S2PMA04	Advanced Algebra	6	-	-	5	25	75	100
2	PART A CORE V	24S2PMA05	Real Analysis II	6	-	-	5	25	75	100
3	PART A CORE VI	24S2PMA06	Partial Differential Equations	6	-	-	4	25	75	100
4	PART A ELECTIVE III		Choose anyone from Group C	4	-	-	3	25	75	100
5	PART A ELECTIVE IV		Choose any one from Group D	4	-	-	3	25	75	100
6	PART B	24S2PHR01	Fundamentals of Human Rights	2	-	-	1	25	75	100
7	PART B NON MAJOR ELECTIVE I		NME - I	2	-	-	2	25	75	100
Total				30			23			700

II YEAR

S.No	CourseCategory	Coursecode	Titleofthecourse	Hrs/Week			Credit Points	MaxMarks		
				L	T	P		CIA	ESE	Total
SEMESTER III										
1	PART A CORE VII	24S3PMA07	Complex Analysis	6	-	-	5	25	75	100
2	PART A CORE VIII	24S3PMA08	Probability Theory	6	-	-	5	25	75	100
3	PART A CORE IX	24S3PMA09	Topology	6	-	-	5	25	75	100
4	PART A CORE X	24S3PMA10	MachineLearning	6	-	-	4	25	75	100
5	PART A ELECTIVE V		Choose any one from Group E	3	-	-	3	25	75	100
6	PART B	24S3PIT01	Internship	-	-	-	2	-	-	-
7	PART B NON MAJOR ELECTIVE II		NME – II	3	-	-	2	25	75	100
Total				30			26			600
SEMESTER IV										
1	PART A CORE XI	24S4PMA11	Functional Analysis	6	-	-	5	25	75	100
2	PART A CORE XII	24S4PMA12	Differential Geometry	6	-	-	5	25	75	100
3	PART A ELECTIVE VI		Choose any one from Group F	4	-	-	3	25	75	100
4	PART A CORE XIII	24S4PMAPR01	Core Project with viva –voce	10	-	-	7	25	75	100
5	PART B SEC		Choose any one from Group G	4	-	-	2	25	75	100
6	PART C	24S4PEX01	Extension Activity	-	-	-	1	-	-	-
Total				30			23			500
OVER ALL TOTAL SEMESTER (I – IV)							92			2300

ELECTIVE COURSES

Semester I : Elective I and Elective II

Elective I to be chosen from Group A

- | | |
|---|-------------|
| 1. Number Theory and Cryptography | -24S1PMAE01 |
| 2. Graph Theory and Applications | -24S1PMAE02 |
| 3. Formal Languages and Automata Theory | -24S1PMAE03 |
| 4. Programming in C++ and Numerical Methods | -24S1PMAE04 |

Elective II to be chosen from Group B

Group B:

- | | |
|--------------------------------------|-------------|
| 1. Lie Groups and Lie Algebras | -24S1PMAE05 |
| 2. Mathematical Programming | -24S1PMAE06 |
| 3. Fuzzy Sets and Their Applications | -24S1PMAE07 |
| 4. Discrete Mathematics | -24S1PMAE08 |

Semester II : Elective III and Elective IV

Elective III to be chosen from Group C

Group C:

- | | |
|--|-------------|
| 1. Algebraic Topology | -24S2PMAE09 |
| 2. Mathematical Statistics | -24S2PMAE10 |
| 3. Statistical Data Analysis using R Programming | -24S2PMAE11 |
| 4. Tensor Analysis and Relativity | -24S2PMAE12 |

Elective IV to be chosen from Group D

Group D :

- | | |
|---|-------------|
| 1. Wavelets | -24S2PMAE13 |
| 2. Modelling and Simulation with Excel | -24S2PMAE14 |
| 3. Machine Learning and Artificial Intelligence | -24S2PMAE15 |
| 4. Neural Networks | -24S2PMAE16 |

Semester III : Elective V

Elective V to be chosen from **Group E**.

Group E:

- | | |
|----------------------------|-------------|
| 1. Algebraic Number Theory | -24S3PMAE17 |
| 2. Fluid Dynamics | -24S3PMAE18 |
| 3. Stochastic Processes | -24S3PMAE19 |
| 4. Python Programming | -24S3PMAE20 |

Semester IV : Elective VI

Elective VI to be chosen from **Group F**.

Group F:

- | | |
|-----------------------------------|-------------|
| 1. Resource Management Techniques | -24S4PMAE21 |
| 2. Algebraic Geometry | -24S4PMAE22 |
| 3. Financial Mathematics | -24S4PMAE23 |
| 4. Mathematical Python | -24S4PMAE24 |

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:

- | | |
|--|-------------|
| 1. Research Tools and Techniques. | -24S4PMAS01 |
| 2. Mathematical computation with sagemath. | -24S4PMAS02 |
| 3. Advanced Latex. | -24S4PMAS03 |
| 4. Office Automation and Its Tool. | -24S4PMAS04 |
| 5. Numerical analysis using SCILAB. | -24S4PMAS05 |
| 6. Differential equations using SCILAB. | -24S4PMAS06 |
| 7. Industrial Mathematics /Statistics using latest programming packages. | -24S4PMAS07 |

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.

- | | |
|---|-------------|
| 1. EDC-I: Mathematics for Life Sciences | -24SPMAED01 |
| 2. EDC-II: Mathematics for Social Sciences | -24SPMAED02 |
| 3. EDC-III: Statistics for Life and Social Sciences | -24SPMAED03 |
| 4. EDC-IV :Game Theory and Strategy | -24SPMAED04 |
| 5. EDC-V: History of Mathematics | -24SPMAED05 |

CORE I – ALGEBRAIC STRUCTURES

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S1PMA01	Core-I	Theory	Y	-	-	7	5

Learning Objectives

- ❖ To introduce the concepts and to develop working knowledge on class equation, solvability of groups, finite abelian groups, linear transformations, real quadratic forms

Course Learning Outcome (for Mapping with POs and PSOs)

Course Outcomes	On Completion of this course, students will:	Program Outcomes
CO1	Recall basic counting principle, define class equations to solve problems, explain Sylow's theorems and apply the theorem to find number of Sylow subgroups	PO1,PO3,PO5
CO2	Define Solvable groups, define direct products, examine the properties of finite abelian groups	PO3, PO6
CO3	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.	PO3,PO5,PO6
CO4	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.	PO3,PO6
CO5	Define trace, define transpose of a matrix, explain the properties of trace and transpose, to find trace, to find transpose of matrix, to prove Jacobson lemma using the triangular form, define symmetric matrix, skew symmetric matrix, adjoint, to define Hermitian, unitary, normal transformations and to verify whether the transformation in Hermitian, unitary and normal	PO1,PO4

CORE I – ALGEBRAIC STRUCTURES

Unit	Details	No. of Hours
I	Another Counting Principle - Class equation for finite groups and its applications - Sylow's theorems. Chapter 2: Sections 2.11 and 2.12	18
II	Direct products – Finite abelian groups-Polynomials Rings – Polynomial over the rational field Chapter 2: Section 2.13 and 2.14 (Theorem 2.14.1 only) Chapter 3: Section 3.9 and 3.10	18
III	Linear Transformations: Canonical forms –Triangular form - Nilpotent transformations. Chapter 6: Sections 6.4, 6.5	18
IV	Jordan form - rational canonical form. Chapter 6 : Sections 6.6 and 6.7	18
V	Trace and transpose –Determinants- Hermitian, unitary, normal transformations. *Self Study : Real quadratic form Chapter 6 : Sections 6.8,6.9 ,6.10 and 6.11.	18
	Total	90
*Model preparation and Power Point Presentation – Related to the above topics are to be considered for Internal Exam only		

Text Books :

- ❖ I.N. Herstein. Topics in Algebra (II Edition) Wiley Eastern Limited, New Delhi, 1975.

Reference Books :

- ❖ M.Artin, Algebra, Prentice Hall of India, 1991.
- ❖ P.B.Bhattacharya, S.K.Jain, and S.R.Nagpaul, Basic Abstract Algebra (II Edition) Cambridge University Press, 1997. (Indian Edition)
- ❖ I.S.Luther and I.B.S.Passi, Algebra, Vol. I –Groups(1996); Vol. II Rings, Narosa Publishing House ,New Delhi, 1999
- ❖ D.S.Malik, J.N. Mordeson and M.K.Sen, Fundamental of Abstract Algebra, McGraw Hill (International Edition), New York. 1997.
- ❖ 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>,
- ❖ www.algebra.com

Mapping with Programme Outcomes: 3 Strong, 2- Medium, 1- Low

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	1	3	2	3	3	3	2	1
CO2	2	1	3	1	3	3	3	2	1
CO3	3	2	3	1	3	3	3	2	1
CO4	1	2	3	2	3	3	3	2	1
CO5	3	1	2	3	3	3	3	2	1
Weightage	12	7	14	9	15	15	15	10	5
Weighted percentage of Course Contribution to POs	2.4	1.4	2.8	1.8	3	3	3	2	1

Course Coordinator

BOS Chairman

CORE II – REAL ANALYSIS I

Subject Code	Subject	Category	L	T	P	HOURS	Credit
24S1PMA02	Core-II	Theory	Y	-	-	7	5

Learning Objectives

- ❖ 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.

Course Learning Outcome (for Mapping with POs and PSOs)

Course Outcomes	On Completion of this course, students will	Program Outcomes
CO1	Analyze and evaluate functions of bounded variation and rectifiable curves	PO1,PO3
CO2	Describe the concept of Riemann-Stieltjes integral and its properties.	PO5, PO6
CO3	Demonstrate the concept of step function, upper function, Lebesgue function and their integrals.	PO3,PO5
CO4	Construct various mathematical proofs using the properties of Lebesgue integrals and establish the Levi monotone convergence theorem.	PO3,PO6
CO5	Formulate the concept and properties of inner products, norms and measurable functions.	PO1,PO4

CORE II – REAL ANALYSIS I

Unit	Details	No. of Hours
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.	18
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	18
III	The Riemann-Stieltjes Integral - Integrators of bounded variation-Sufficient conditions for the existence of Riemann-Stieltjes integrals-Necessary conditions for the existence of RS integrals-Mean value theorems -integrals as a function of the interval – Second fundamental theorem of integral calculus-Change of variable -Second Mean Value Theorem for Riemann integral- Riemann-Stieltjes integrals depending on a parameter- Differentiation under integral sign-Lebesgue criterion for existence of Riemann integrals. Chapter-7 : 7.15 to 7.26	18
IV	Infinite Series and infinite Products: Double sequences- Double series - Rearrangement theorem for double series – A sufficient condition for equality of iterated series - Multiplication of series – Cesaro summability - Infinite products. Chapter - 8 Sec, 8.20, 8.21 to 8.26 Power series - Multiplication of power series - The Taylor's series generated by a function - Bernstein's theorem - Abel's limit theorem-Tauber's theorem. Chapter 9 : Sections 9.14 9.15, 9.19, 9.20, 9.22, 9.23 *Power Point Presentation : Power series Applications	18
V	Sequences of Functions: Point wise 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 *Self Study: Mean convergence. Chapter -9 Sec 9.1 to 9.6, 9.8,9.9,9.10,9.11, 9.13.	18
	Total	90
*Model preparation and Power Point Presentation – Related to the above topics are to be considered for Internal Exam only		

Text Books :

- ❖ Tom M. Apostol : Mathematical Analysis, 2nd Edition, Addison-Wesley Publishing Company Inc. New York, 1974.

Reference Books :

- ❖ Bartle, R.G. Real Analysis, John Wiley and Sons Inc., 1976.
- ❖ Malik. S.C. and Savita Arora. Mathematical Analysis, Wiley Eastern Limited. New Delhi, 1991.
- ❖ Sanjay Arora and Bansi Lal, Introduction to Real Analysis, Satya Prakashan, New Delhi, 1991.
- ❖ Gelbaum, B.R. and J. Olmsted, Counter Examples in Analysis, Holden day, San Francisco, 1964.
- ❖ 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

Mapping with Programme Outcomes: 3 Strong, 2- Medium, 1- Low

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	1	3	2	3	3	3	2	1
CO2	2	1	3	1	3	3	3	2	1
CO3	3	2	3	1	3	3	3	2	1
CO4	1	2	3	2	3	3	3	2	1
CO5	3	1	2	3	3	3	3	2	1
Weightage	12	7	14	9	15	15	15	10	5
Weighted percentage of Course Contribution to POs	2.4	1.4	2.8	1.8	3	3	3	2	1

Course Coordinator

BOS Chairman

CORE III – ORDINARY DIFFERENTIAL EQUATIONS

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S1PMA03	Core-III	Theory	Y	Y	-	6	4

Learning Objectives

- ❖ 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 firstorder differential equations.

Course Learning Outcome (for Mapping with POs and PSOs)

Course Outcomes	On Completion of this course, students will:	Program Outcomes
CO1	Establish the qualitative behavior of solutions of systems of differential equations .	PO1,PO3
CO2	Recognize the physical phenomena modeled by differential equations and dynamical systems.	PO5, PO6
CO3	Analyze solutions using appropriate methods and give examples.	PO5,PO6
CO4	Formulate Green's function for boundary value problems.	PO3,PO6
CO5	Understand and use various theoretical ideas and results that underlie the mathematics in this course	PO4,PO6

CORE III – ORDINARY DIFFERENTIAL EQUATIONS

Unit	Details	No. of Hours
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 *Poster Presentation : Initial value problems in Real World Scenario	18
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.	18
III	Linear equation with variable coefficients: Initialvalue 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)	18
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 section 5 and 9)	18
V	Existence and uniqueness of solutions to first order equations: Equation with variable separated – Exact equation – method of successive approximations – the Lipschitz condition - Non-local existence of solutions-Approximations to and uniqueness of solutions. *Self Study: Convergence of the successive approximations and the existence theorem. Chapter 5 : Sections 1 to 6, Sec-7,8 (Omit section 7 to 9)	18
	Total	90
*Model preparation and Power Point Presentation – Related to the above topics are to be considered for Internal Exam only		

Text Books :

- ❖ E.A.Coddington, A introduction to ordinary differential equations (3rdPrinting) Prentice-Hall of India Ltd.,New Delhi, 1987

Reference Books :

- ❖ Williams E. Boyce and Richard C. DI Prima, Elementary differential equations and boundary valueproblems, John Wiley and sons, New York, 1967.
- ❖ George F Simmons, Differential equations with applications and historical notes, Tata McGraw Hill, NewDelhi, 1974.
- ❖ N.N. Lebedev, Special functions and their applications, Prentice Hall of India, New Delhi, 1965.
- ❖ W.T. Reid. Ordinary Differential Equations, John Wiley and Sons,New York, 1971
- ❖ M.D.Raisinghania, Advanced Differential Equations, S.Chand &Company Ltd. New Delhi 2001
- ❖ B.Rai, D.P.Choudary and H.I. Freedman, A Course in Ordinary Differential Equations, Narosa PublishingHouse, New Delhi,2002.

Website and e-Learning Source :

- ❖ <http://mathforum.org>
- ❖ <http://ocw.mit.edu/ocwweb/Mathematics>
- ❖ <http://www.opensource.org>
- ❖ www.mathpages.com

Mapping with Programme Outcomes: 3 Strong, 2- Medium, 1- Low:

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	1	3	2	3	3	3	2	1
CO2	2	1	3	1	3	3	3	2	1
CO3	3	2	3	1	3	3	3	2	1
CO4	1	2	3	2	3	3	3	2	1
CO5	3	1	2	3	3	3	3	2	1
Weightage	12	7	14	9	15	15	15	10	5
Weighted percentage of Course Contribution to POs	2.4	1.4	2.8	1.8	3	3	3	2	1

Course Coordinator

BOS Chairman

ELECTIVE 1 – NUMBER THEORY AND CRYPTOGRAPHY

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S1PMAE01	Elective-1	Theory	Y	Y	-	5	3

Learning Objectives

- ❖ To understand fundamental number-theoretic algorithms such as the Euclidean algorithm, the Chinese Remainder algorithm, binary powering, and algorithms for integer arithmetic.
- ❖ To understand fundamental algorithms for symmetric key and public- key cryptography.
- ❖ To understand the number-theoretic foundations of modern cryptography and the principles behind their security.
- ❖ To implement and analyze cryptographic and number-theoretic algorithms.

Course Learning Outcome (for Mapping with POs and PSOs)

Course Outcomes	On Completion of this course, students will:	Program Outcomes
CO1	Illustrate the implications of properties of divisibility and primes.	PO1,PO3
CO2	Distinguish the DES and the AES.	PO1
CO3	Understanding the Law of Quadratic Reciprocity & Quadratic Residues.	PO2,PO3
CO4	Define the fundamentals of cryptography, such as encryption, Authentication and digital signature.	PO5,PO6
CO5	Explain how elliptic curves are used in certain Crypto-graphic algorithms.	PO1,PO4

ELECTIVE I – NUMBER THEORY AND CRYPTOGRAPHY

Unit	Details	No. of Hours
I	Elementary Number Theory: Time Estimates for doing arithmetic – divisibility and Euclidean algorithm – Congruences – Application to factoring. (Chapter 1)	15
II	Introduction to Classical Crypto systems – Some simple crypto systems – Enciphering matrices DES (Chapter 3)	15
III	Finite Fields, Quadratic Residues and Reciprocity. (Chapter 2)	15
IV	Public Key Cryptography. (Chapter 4)	15
V	Primality, Factoring, Elliptic curves . *Self Study : Elliptic Curve Crypto Systems. Chapter 5, sections 1,2,3 &5 (omit section 4), Chapter 6, sections 1& 2 only).	15
	Total	75
*Model preparation and Power Point Presentation – Related to the above topics are to be considered for Internal Exam only		

Text Books :

- ❖ Neal Koblitz, A Course in Number Theory and Cryptography, Springer-Verlag, New York, 1987

Reference Books :

- ❖ Niven and H.S. Zuckermann, An Introduction to Theory of Numbers (Edn. 3), Wiley Eastern Ltd., New Delhi, 1976
- ❖ David M. Burton, Elementary Number Theory, Brown Publishers, Iowa, 1989
- ❖ K. Ireland and M. Rosen, A Classical Introduction to Modern Number Theory, Springer Verlag, 1972
- ❖ N. Koblitz, Algebraic Aspects of Cryptography, Springer 1998.

Website and e-Learning Source :

- ❖ <https://nptel.ac.in/courses/111101137>
- ❖ <https://archive.nptel.ac.in/courses/106/103/106103015/>
- ❖ https://onlinecourses-archive.nptel.ac.in/noc17_cs36/preview

Mapping with Programme Outcomes: 3 Strong, 2- Medium, 1- Low

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	3	3	3	3
CO2	3	2	2	1	2	2	3	2	3
CO3	3	3	3	2	3	3	3	3	3
CO4	3	1	3	3	3	3	3	2	3
CO5	3	2	3	3	3	3	3	3	3
Weightage	15	11	14	12	14	14	15	13	15
Weighted percentage of Course Contribution to POs	3	2.2	2.8	2.4	2.8	2.8	3	2.6	3

Course Coordinator

BOS Chairman

ELECTIVE I – GRAPH THEORY AND APPLICATIONS

Subject Code	Subject	Category	L	T	P	HOURS	Credit
24S1PMAE02	Elective-I	Theory	Y	Y	-	5	3

Learning Objectives

- ❖ To understand the fundamental definitions and concepts of graph theory
- ❖ To understand Trees, Eulerian Graphs, Matching, Vertex colorings, Edge colorings, Planar graphs

Course Learning Outcome (for Mapping with POs and PSOs)

Course Outcomes	On Completion of this course, students will be able to:	Program Outcomes
CO1	Define fundamental graph theory concepts, including subgraphs, degrees of vertices, paths, and connectedness.	PO1,PO4,PO6
CO2	Explaining concepts related to graph connectivity, including vertex cuts, edge cuts, and measures of connectivity.	PO2, PO4,PO6
CO3	Identify and analyze independent sets and matchings in graphs, with a particular focus on vertex-independent sets, vertex coverings, and matchings in bipartite graphs.	PO1,PO5,PO6
CO4	Apply various graph coloring techniques, including vertex colorings, edge colorings, and the calculation of chromatic polynomials.	PO1,PO3,PO6
CO5	Gain the ability to distinguish between planar and non planar graphs, use Euler's formula to analyze graph properties, and comprehend the significance of the Four-Color Theorem and the Heawood Five-Color Theorem	PO1,PO4,PO5

ELECTIVE I – GRAPH THEORY AND APPLICATIONS

Unit	Details	No. of Hours
I	Basic Results: Introduction-Basic Concepts- Subgraphs- Degrees of Vertices - Paths and Connectedness - Automorphism of a Simple Graph. (Chapter 1: Sections 1.1 - 1.6). Directed Graphs: Introduction-Basic Concepts-Tournaments.(Chapter 2 : Sections 2.1 - 2.3). *Students submit a detail tournament schedule with a corresponding directed graph, ensuring that all participants are fairly matched.	15
II	Connectivity and Trees: Connectivity: Introduction-Vertex cut and Edge Cut-Connectivity and Edge Connectivity.(Chapter 3: Sections 3.1- 3.3). Trees: Introduction-Definition, Characterization and Simple Properties-Centers and Centroids- Cutting the Number of Spanning Trees- Cayley's Formula.(Chapter 4: Sections 4.1- 4.5).	15
III	Independent Sets, Matchings and Cycles: Independent Sets and Matchings: Introduction-Vertex-Independent Sets and Vertex Coverings-Edge-Independent sets-Matchings and Factors-Matchings in Bipartite Graphs. (Chapter 5: Sections 5.1- 5.5) . Cycles: Introduction- Eulerian Graphs Hamiltonian Graphs. (Chapter 6: Sections 6.1- 6.3)	15
IV	Graph Colorings: Introduction-Vertex colorings-Critical Graphs-Edge colorings of Graphs-Kirkman's Schoolgirl-Problem- Chromatic Polynomials (Chapter 7: Sections 7.1 ,7.2 ,7.3, (7.2.1 & 7.2.3 only) ,7.6, 7.8, and 7.9). *Ability to minimize the number of time slots by edge colouring	15
V	Planarity: Introduction- Planar and Nonplanar Graphs – Euler Formula and its Consequences K_4 and $K_{3,3}$ are Nonplanar Graphs – Dual of a Plane Graph- The Four-Color Theorem and the Heawood Five-Color Theorem-Hamiltonian Plane Graphs. *Self Study: Tait Coloring.(Chapter 8: Sections 8.1 - 8.6 ,8.8 and 8.9).	15
	Total	75
*Model preparation and Power Point Presentation – Related to the above topics are to be considered for Internal Exam only		

Text Books :

- ❖ R.Balakrishnan and K.Ranganathan, Text Book of Graph Theory, (2nd Edition), Springer, NewYork,2012.

Reference Books :

- ❖ J.A.Bondy and U.S.R. Murty, Graph Theory with Applications, North Holland, New York, 1982.
- ❖ Narasing Deo, Graph Theory with Application to Engineering and Computer Science, Prentice Hall of India, NewDelhi. 2003.
- ❖ F. Harary, Graph Theory, Addison – Wesely Pub. Co. The Mass. 1969.
- ❖ L. R.. Foulds, Graph Theory Application, Narosa Publ. House, Chennai, 1933.

Website and e-Learning Source :

- ❖ <http://mathforum.org>, <http://ocw.mit.edu/ocwwweb/Mathematics>,
- ❖ <http://www.opensource.org>, www.mathpages.com

Mapping with Programme Outcomes: 3 Strong, 2- Medium, 1- Low

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	3	3	3	3
CO2	3	2	2	1	2	2	3	2	3
CO3	3	3	3	2	3	3	3	3	3
CO4	3	1	3	3	3	3	3	2	3
CO5	3	2	3	3	3	3	3	3	3
Weightage	15	11	14	12	14	14	15	13	15
Weighted percentage of Course Contribution to POs	3	2.2	2.8	2.4	2.8	2.8	3	2.6	3

Course Coordinator**BOS Chairman**

ELECTIVE I – FORMAL LANGUAGES AND AUTOMATA THEORY

Subject Code	Subject	Category	L	T	P	HOURS	Credit
24S1PMAE03	Elective -I	Theory	Y	Y	-	5	3

Learning Objectives

- ❖ To teach the student to identify different formal language classes and their relationships
- ❖ To teach the student the theoretical foundation for designing compilers.
- ❖ To teach the student to use the ability of applying logical skills.
- ❖ Teach the student to prove or disprove theorems in automata theory using its properties
- ❖ To teach the student the techniques for information processing.
- ❖ Understand the theory behind engineering applications.

Course Learning Outcome (for Mapping with POs and PSOs)

Course Outcomes	On Completion of this course, students will able to:	Program Outcomes
CO1	Apply knowledge in designing or enhancing compilers.	PO3,PO4
CO2	Design grammars and automata (recognizers) for different language classes.	PO1, PO5
CO3	Apply knowledge in developing tools for language processing or text processing	PO1,PO6
CO4	Proficient in the concepts and applications of pushdown automata (PDA) for recognizing context-free languages (CFL), including the equivalence of CFLs and PDAs. They will explore deterministic context-free languages (DCFL) and deterministic pushdown automata (DPDA)	PO1,PO3,PO6
CO5	Acquire a deep understanding of Turing machines, including their design and use in recognizing recursively enumerable languages and computable functions.	PO1,PO4,PO5

ELECTIVE I – FORMAL LANGUAGES AND AUTOMATA THEORY

Unit	Details	No. of Hours
I	Fundamentals: Strings, Alphabet, Language, Operations, Finite state machine, definitions, finite automaton model, acceptance of strings, and languages, FA, transition diagrams and Language recognizers. Finite Automata: Deterministic finite automaton, Non deterministic finite automaton and NFA with ϵ transitions - Significance, acceptance of languages. Conversions and Equivalence : Equivalence between NFA with and without ϵ transitions, NFA to DFA conversion, minimization of FSM, equivalence between two FSMs, Finite Automata with output-Moore and Melay machines.	15
II	Regular Languages: Regular sets, regular expressions, identity rules, Conversion finite Automata for a given regular expressions, Conversion of Finite Automata to Regular expressions. Pumping lemma of regular sets, closure properties of regular sets(proofs not required).	15
III	Grammar Formalism: Regular grammars -right linear and left linear grammars, equivalence between regular linear grammar and FA, inter conversion, Context free grammar, derivation trees, sentential forms. Right most and leftmost derivation of strings. Context Free Grammars: Ambiguity in context free grammars. Minimization of Context Free Grammars. Chomsky normal form, Greibach normal form, Pumping Lemma for Context Free Languages. Enumeration of properties of CFL (proofs omitted).	15
IV	Push Down Automata: Push down automata, definition, model, acceptance of CFL, Acceptance by final state and acceptance by empty state and its equivalence. Equivalence of CFL and PDA, interconversion. (Proofs not required). Introduction to DCFL and DPDA. LINEAR BOUNDED AUTOMATA(LBA):LBA, context Sensitive grammars ,CS languages	15
V	Turing Machine: Turing Machine, definition, model, design of TM, Computable functions, recursively enumerable languages. Church's hypothesis, counter machine, types of Turing machines (proofs not required). Computability Theory: Chomsky hierarchy of languages, linear bounded automata and context sensitive language, LR(0) grammar, decidability of problems, Universal Turing Machine, undecidability of posts. Correspondence problem, Turing reducibility,. *Self Study: Definition of P and NP problems, NP complete and NP hard problems.	15
	Total	60
*Model preparation and Power Point Presentation – Related to the above topics are to be considered for Internal Exam only		

Text Books :

- ❖ Introduction to Automata Theory Languages and Computation. Hopcroft H.E. and Ullman J. D. Pearson Education.
- ❖ Introduction to Theory of Computation - Sipser 2nd edition Thomson

Reference Books :

- ❖ .Introduction to Computer Theory, Daniel I.A. Cohen, John Wiley.
- ❖ .Introduction to languages and the Theory of Computation ,John C Martin, TMH
- ❖ Elements of Theory of Computation, Lewis H.P. & Papadimitriou C.H. Pearson /PHI.
- ❖ Theory of Computer Science and Automata languages and computation -Mishra and Chandrashekar, 2nd edition, PHI.
- ❖ Theory of Computation, By K.V.N. Sunitha and N.Kalyani

Website and e-Learning Source :

- ❖ <http://mathforum.org>
- ❖ <http://ocw.mit.edu/ocwweb/Mathematics>,
- ❖ <http://www.opensource.org>,
- ❖ www.mathpages.com

Mapping with Programme Outcomes: 3 Strong, 2- Medium, 1- Low

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	2	3	3	3	3	3	3	3
CO2	3	2	2	1	2	2	3	2	3
CO3	3	3	3	2	3	3	3	3	3
CO4	3	2	3	3	3	3	3	1	3
CO5	3	2	3	3	3	3	2	3	2
Weightage	15	11	14	12	14	14	14	12	14
Weighted percentage of Course Contribution to Pos	3	2.2	2.8	2.4	2.8	2.8	2.8	2.4	2.8

Course Coordinator

BOS Chairman

ELECTIVE I – PROGRAMMING IN C++ AND NUMERICAL ANALYSIS

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S1PMAE04	Elective -I	Theory	Y	Y	-	5	3

Learning Objectives

- ❖ This courses introduces a higher level language C++ and numerical methods for hands-on experience on computers. Stress is also given on the error analysis.

Course Learning Outcome (for Mapping with POs and PSOs)

Course Outcomes	On Completion of this course, students will able to:	Program Outcomes
CO1	Understand principles of OOP, including tokens, expressions, control structures, and the creation and destruction of objects using classes, constructors, and destructors.	PO1,PO3,PO4
CO2	Master operator overloading, type conversions, inheritance, polymorphism, and managing console I/O operations and file handling in complex applications.	PO1, PO5
CO3	Apply various numerical methods like bisection, secant, and Newton's method to solve non-linear equations and analyze propagated and generated errors in floating point arithmetic.	PO2,PO3
CO4	Solve systems of linear equations using methods like Gauss elimination and Gauss-Seidel, and perform numerical differentiation and integration using Newton-Cotes formulas and Gaussian quadrature.	PO1,PO4
CO5	Employ methods like Runge-Kutta and multi-step techniques to solve ordinary differential equations and understand difference equations for accurate computation.	PO1,PO3,PO4

ELECTIVE I – PROGRAMMING IN C++ AND NUMERICAL ANALYSIS

Unit	Details	No. of Hours
I	Principles of OOP-Tokens-Expressions, Control Structures-Functions-Classes and Objects-constructors and destructors. Chapter 1 to 6	15
II	Operator Overloading and type Conversions - Inheritance - Pointers, Virtual Functions and Polymorphism-Managing Console I/O Operations-Working with Files . Chapter 7 to 11	15
III	Finite Digit Arithmetic and Errors Floating point arithmetic - Propagated Error - Generated Error - Error in Evaluation of a function $f(x)$. - Non-linear Equations: Bisection method- Secant Method - Regula Falsi Method - Newton's method - Muller's method - Fixed Point method - Chapters 1, 2 (Only 2.1 to 2.6)	15
IV	System of Linear Equations Gauss- Elimination Method - Crout's method - Inverse of a matrix - Condition numbers and errors - Jacobi's method - Gauss-Seidel Method - Relaxation method. Numerical Differentiation and Integration: Numerical Differentiation - Numerical Integration - Newton-Cotes Formulas - Gaussian Quadrature - Double Integral .Chapter 3 and 5 : 5.1 to 5.5 and 5.7(omit 5.6)	15
V	Ordinary Differential Equations: Difference equation - Differential Equations:Single Step method-Runge-Kutta Method. *Self Study: Multi-step methods. Chapter 6: 6.1 to 6.4 (omit 6.5).	15
	Total	75
*Model preparation and Power Point Presentation – Related to the above topics are to be considered for Internal Exam only		

Text Books :

- ❖ E. Balagurusamy, Object Oriented Programming with C++, Tata McGraw Hill, New Delhi, 1999.
- ❖ Devi Prasad, An Introduction to Numerical Analysis (3rd edn) Narosa Publishing House, New Delhi, 2006.

Reference Books :

- ❖ D. Ravichandran, Programming with C++, Tata McGraw Hill, New Delhi, 1996
- ❖ Conte and de Boor, Numerical Analysis, McGraw Hill, New York, 1990
- ❖ John H. Mathews, Numerical Methods for Mathematics, Science and Engineering (2nd Edn.), Prentice Hall, New Delhi, 2000

Website and e-Learning Source :

- ❖ <http://mathforum.org>
- ❖ <http://ocw.mit.edu/ocwwweb/Mathematics>
- ❖ <http://www.opensource.org>,
- ❖ www.mathpages.com

Mapping with Programme Outcomes: 3 Strong, 2- Medium, 1- Low

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	3	1	2	3
CO2	3	2	2	1	2	2	3	3	3
CO3	3	3	3	2	3	3	3	2	3
CO4	3	1	3	3	3	3	3	3	3
CO5	3	2	3	3	3	3	3	2	3
Weightage	13	12	14	13	16	17	13	12	15
Weighted percentage of Course Contribution to POs	2.6	2.4	2.8	2.6	3.2	3.4	2.6	2.4	3

Course Coordinator

BOS Chairman

ELECTIVE II – LIE GROUPS and LIE ALGEBRAS

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S1PMAE05	Elective –II	Theory	Y	Y	-	5	3

Learning Objectives

- ❖ This courses introduces a higher level language C++ and numerical methods for hands-on experience on computers. Stress is also given on the error analysis.

Course Learning Outcome (for Mapping with POs and PSOs)

Course Outcomes	On Completion of this course, students will:	Program Outcomes
CO1	Demonstrate systematic understanding of key aspects of Matrix Lie Groups and Lie Lie groups	PO1,PO3,
CO2	Determine the exponential of a matrix.	PO2, PO3
CO3	Differentiate Lie groups and Lie Algebras	PO1,PO4
CO4	Find the representation of $sl(2; \mathbb{C})$	PO3,PO5
CO5	Explain reductive Lie algebra	PO1,PO2

ELECTIVE II – LIE GROUPS AND LIE ALGEBRAS

Unit	Details	No. of Hours
I	Matrix Lie Groups Chapter 1	15
II	The Matrix Exponential Chapter 2	15
III	Lie Algebras Chapter 3	15
IV	Basic Representation Theory Chapter 4	15
V	Semi simple Lie Algebras- Representation of semisimple Lie algebras: Weights of Representation –Introduction to Verma modules-Universal enveloping algebras. *Self Study: Abstract root systems Chapter 7, 9 (sec 9.1, 9.2, 9.3 only)	15
	Total	75
*Model preparation and Power Point Presentation – Related to the above topics are to be considered for Internal Exam only		

Text Books :

- ❖ Brain Hall, Lie Groups, Lie Algebras and Representations: An Elementary Introduction (Second Edition), Springer, USA, 2015.

Reference Books :

- ❖ V. S. Varadarajan, Lie groups, Lie algebras and their representations, Springer 1984.
- ❖ Brian Hall, Lie groups, Lie algebras and representations, Springer 2003.
- ❖ Barry Simon, Representations of finite and compact groups, AMS 1996.
- ❖ A. W. Knap, Representation theory of semisimple Lie groups. An overview based on examples, Princeton university press 2002.
- ❖ S. Kumaresan S, A course in differential geometry and Lie groups, Texts and Readings in Mathematics, 22. Hindustan Book Agency, New Delhi, 2002.

Website and e-Learning Source :

- ❖ <https://archive.nptel.ac.in/courses/111/108/111108134/>
- ❖ <https://www.digimat.in/nptel/courses/video/111108134/L42.html>

Mapping with Programme Outcomes: 3 Strong, 2- Medium, 1- Low

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	2	3	2	2	2	3	2	2
CO2	2	2	2	2	1	1	3	1	1
CO3	3	2	2	2	1	1	3	2	2
CO4	2	2	3	2	2	1	2	2	1
CO5	3	2	2	2	1	2	2	2	2
Weightage	13	10	12	10	7	7	13	9	8
Weighted percentage of Course Contribution to POs	2.6	2	2.4	2	1.4	1.4	2.6	1.8	1.6

Course Coordinator**BOS Chairman**

ELECTIVE II – MATHEMATICAL PROGRAMMING

Subject Code	Subject	Category	L	T	P	HOURS	Credit
24S1PMAE06	Elective – II	Theory	Y	Y	-	5	3

Learning Objectives

- ❖ This course introduces advanced topics in Linear and non-linear Programming

Course Learning Outcome (for Mapping with POs and PSOs)

Course Outcomes	On Completion of this course, students will able to:	Program Outcomes
CO1	Solve integer linear programming problems using methods like Gomory's cutting planes and branch and bound	PO1,PO2,PO3
CO2	Handle unconstrained and constrained optimization problems and solve non-linear programming issues using methods like Wolfe's modified simplex and Beale's method for quadratic programming	PO1, PO3
CO3	Learn the theory of the simplex method, including the handling of canonical forms, slack variables, and issues like degeneracy and unbounded solutions in linear programming.	PO2,PO3
CO4	Implement the revised simplex method, compare it with the traditional simplex method, and solve bounded variables LP problems using advanced computational techniques.	PO1,PO3,PO4
CO5	Investigate variations in LP parameters using parametric linear programming and develop goal programming models to achieve multiple objectives, utilizing graphical and modified simplex methods for solutions.	PO1,PO3,PO5

ELECTIVE II – MATHEMATICAL PROGRAMMING

Unit	Details	No. of Hours
I	INTEGER LINEAR PROGRAMMING: Types of Integer Linear Programming Problems - Concept of Cutting Plane - Gomory's All Integer Cutting Plane Method - Gomory's mixed Integer Cutting Plane method - Branch and Bound Method. - Zero- One Integer Programming. Dynamic Programming: Characteristics of Dynamic Programming Problem - Developing Optimal Decision Policy - Dynamic Programming Under Certainty - DP approach to solve LPP. Chapter-7: 7.1 - 7.7 ,Chapter-20: 20.1 - 20.5	15
II	CLASSICAL OPTIMIZATION METHODS: Unconstrained Optimization - Constrained Multi-variable Optimization with Equality Constraints - Constrained Multi-variable Optimization with inequality Constraints Non-linear Programming Methods: Examples of NLPP - General NLPP - Graphical solution - Quadratic Programming - Wolfe's modified Simplex Methods - Beale's Method. Chapter-23: 23.1 - 23.4 Chapter-24: 24.1 - 24.4	15
III	THEORY OF SIMPLEX METHOD: Canonical and Standard form of LP - Slack and Surplus Variables - Reduction of any Feasible solution to a Basic Feasible solution - Alternative Optimal solution - Unbounded solution - Optimality conditions - Some complications and their resolutions - Degeneracy and its resolution. Chapter-25: 25.1 - 25.4, 25.6-25.9.	15
IV	REVISED SIMPLEX METHOD: Standard forms for Revised simplex Method - Computational procedure for Standard form I - comparison of simplex method and Revised simplex Method. Bounded Variables LP problem: The simplex algorithm Chapter-26: 26.1 - 26.4 Chapter-28: 28.1, 28.2.	15
V	PARAMETRIC LINEAR PROGRAMMING: Variation in the coefficients c_j , Variations in the Right hand side, b_i . Goal Programming: Difference between LP and GP approach - Concept of Goal Programming - Goal Programming Model formulation - Graphical Solution Method of Goal Programming, *Self Study : Modified Simplex method of Goal Programming. Chapter-29: 29.1 - 29.3	15
	Total	75
*Model preparation and Power Point Presentation – Related to the above topics are to be considered for Internal Exam only		

Text Books :

- ❖ J.K.Sharma, Operations Research, Theory and Applications, Third Edition (2007) Macmillan India Ltd.

Reference Books :

- ❖ Hamdy A. Taha, Operations Research, (seventh edition) Prentice - Hall of India Private Limited, New Delhi, 1997.
- ❖ F.S. Hillier & J.Lieberman Introduction to Operation Research (7th Edition) TataMcGraw Hill Company, New Delhi, 2001.
- ❖ Beightler. C, D.Phillips, B. Wilde ,Foundations of Optimization (2nd Edition) Prentice Hall Pvt Ltd., New York, 1979
- ❖ S.S. Rao - Optimization Theory and Applications, Wiley Eastern Ltd. New Delhi. 1990

Website and e-Learning Source :

- ❖ <http://mathforum.org>, <http://ocw.mit.edu/ocwweb/Mathematics>,
- ❖ <http://www.opensource.org>, www.mathpages.com

Mapping with Programme Outcomes: 3 Strong, 2- Medium, 1- Low

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	3	3	3	3
CO2	3	2	2	1	2	2	3	2	3
CO3	3	3	3	2	3	3	3	3	3
CO4	3	1	3	3	3	3	3	2	3
CO5	3	2	3	3	3	3	3	3	3
Weightage	15	11	14	12	14	14	15	13	15
Weighted percentage of Course Contribution to POs	3	2.2	2.8	2.4	2.8	2.8	3	2.6	3

Course Coordinator**BOS Chairman**

ELECTIVE II – FUZZY SETS AND THEIR APPLICATIONS

Subject Code	Subject	Category	L	T	P	HOURS	Credit
24S1PMAE07	ELECTIVE – II	Theory	Y	Y	-	5	3

Learning Objectives

- ❖ This course introduces advanced topics in Linear and non-linear Programming

Course Learning Outcome (for Mapping with POs and PSOs)

Course Outcomes	On Completion of this course, students will able to:	Program Outcomes
CO1	Grasp the fundamental types, concepts, and properties of fuzzy sets, appreciating their significance and paradigm shift	PO1,PO3,PO4
CO2	Compare fuzzy sets with crisp sets, apply the extension principle, and perform operations like fuzzy complements.	PO1, PO5
CO3	Perform operations on fuzzy sets, including intersections using t-norms, unions using t-conorms, and various aggregation techniques	PO1,PO2,PO5
CO4	Use fuzzy numbers and linguistic variables for arithmetic operations on intervals and understand the lattice structure of fuzzy numbers.	PO1,PO6
CO5	Explore methods for constructing fuzzy sets, employing direct and indirect approaches involving experts and sample data.	PO1,PO3,PO6

ELECTIVE II – FUZZY SETS AND THEIR APPLICATIONS

Unit	Details	No. of Hours
I	Fuzzy sets: Fuzzy sets – Basic types – Basic concepts - Characteristics – Significance of the paradigm shift – Additional properties of α - Cuts (Chapter 1: Sections 1.3 to 1.5 and Chapter 2: Sections 2.1)	15
II	Fuzzy Sets Versus CRISP Sets: Representation of Fuzzy sets – Extension principle of Fuzzy sets – Operation on Fuzzy Sets – Types of Operation – Fuzzy complements. (Chapter 2: Sections 2.2 to 2.3 and Chapter 3: Sections 3.1 to 3.2)	15
III	Operations on Fuzzy Sets: Fuzzy intersection – t- norms, Fuzzy unions – t conorms – Combinations of operations – Aggregation operations.(Chapter 3: Sections 3.3 to 3.6)	15
IV	Fuzzy Arithmetic: Fuzzy numbers – Linguistic variables– Arithmetic operation on intervals – Lattice of Fuzzy numbers. (Chapter 4: Sections 4.1 to 4.4)	15
V	Constructing Fuzzy Sets: Methods of construction: An overview – Direct methods with one expert – Direct method with multiple experts – indirect method with multiple experts and one expert, *Self Study : Construction from sample data. (Chapter 10: Sections 10.1 to 10.7)	15
	Total	75
*Model preparation and Power Point Presentation – Related to the above topics are to be considered for Internal Exam only		

Text Books :

- ❖ G.J. Klir, and Bo Yuan, Fuzzy Sets and fuzzy Logic: Theory and Applications, Prentice Hall of India Ltd., NewDelhi, 2005.

Reference Books :

- ❖ H.J. Zimmermann, Fuzzy Set Theory and its Applications, Allied Publishers, Chennai, 1996.
- ❖ Kaufman, Introduction to the Theory of Fuzzy Subsets, Academic Press, New York, 1975.
- ❖ V.Novak, Fuzzy Sets and Their Applications, Adam Hilger, Bristol, 1969.

Website and e-Learning Source :

- ❖ <http://mathforum.org>, <http://ocw.mit.edu/ocwwweb/Mathematics>,
- ❖ <http://www.opensource.org>, www.mathpages.com

Mapping with Programme Outcomes: 3 Strong, 2- Medium, 1- Low

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	3	3	3	3
CO2	3	2	2	1	2	2	3	2	3
CO3	3	3	3	2	3	3	3	3	3
CO4	3	1	3	3	3	3	3	2	3
CO5	3	2	3	3	3	3	3	3	3
Weightage	15	11	14	12	14	14	15	13	15
Weighted percentage of Course Contribution to Pos	3	2.2	2.8	2.4	2.8	2.8	3	2.6	3

Course Coordinator

BOS Chairman

ELECTIVE II – DISCRETE MATHEMATICS

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S1PMAE08	Elective – II	Theory	Y	Y	-	5	3

Learning Objectives :

- ❖ The objective of this course is to equip students with a comprehensive understanding of the fundamental concepts and techniques in discrete mathematics, including logic, set theory, combinatorics, graph theory, and algorithms.

Course Learning Outcome (for Mapping with POs and PSOs)

Course Outcomes	On Completion of this course, students will able to:	Program Outcomes
CO1	Understand the fundamentals of logic, propositional equivalences, predicates, quantifiers, and the growth of functions to apply in proofs and algorithms	PO1,PO4,PO5
CO2	Master basic counting principles, including permutations, combinations	PO1, PO6
CO3	Apply advanced counting techniques, such as solving linear recurrence relations and using generating functions to analyze complex sequence and patterns	PO2,PO3
CO4	Analyze and simplify Boolean functions, represent logic circuits, and minimize circuits	PO1,PO3,PO4
CO5	Gain knowledge about Finite-State machines with No Output and turing machines.	PO1,PO5,PO6

ELECTIVE II – DISCRETE MATHEMATICS

Unit	Details	No. of Hours
I	The Foundations: Logic and Proofs : Propositional - Applications of Propositional -Propositional Equivalences - Predicates and Quantifiers - Rules of inference (Chapter 1: Sections 1.1 - 1.6). Algorithms: The Growth of Functions.(Chapter 3: Section 3.2). *PPT Presentation: Application of logic gates used in computer science	15
II	Counting: The Basics of Counting- The Pigeonhole Principle -Permutations and Combinations - Binomial Coefficients and Identities - Generalized Permutations andCombinations - Generating Permutations and Combinations. (Chapter 5: Sections 5.1- 5.3, 5.5 and 5.6).	15
III	Advanced Counting Techniques: Applications of Recurrence Relations-Solving Linear Recurrence Relations Generating Functions. (Chapter 6: Sections 6.1, 6.2 and 6.4).	15
IV	Boolean Algebra: Boolean Functions- Representing Boolean Functions - Logic Gates - Minimization of Circuits. (Chapter 10:Sections 10.1 -10.4). *Creating a digital circuit using logic gates to automate the lighting system in a house based on sensor inputs.	15
V	Modeling Computation: Finite-State machines with Output- Finite-State machines with No Output *Self Study: Turing Machines (Chapter 12: Sections 12.2, 12.3 and 12.5).	15
	Total	75
*Model preparation and Power Point Presentation – Related to the above topics are to be considered for Internal Exam only		

Text Books :

- ❖ Kenneth H.Rosen, Discrete Mathematics and it's Applications,7th Edition, WCB / McGraw Hill Education ,NewYork,2008

Reference Books :

- ❖ J.P. Trembley and R.Manohar, Discrete Mathematical Structures applications to Computer Science, Tata McGraw Hills,New Delhi.
- ❖ T.Veerarajan,Discrete Mathematics with Graph Theory and Combinatorics, Tata McGraw Hills Publishing Company Limited ,7th Reprint,2008.

Website and e-Learning Source :

- ❖ <http://mathforum.org>, <http://ocw.mit.edu/ocwweb/Mathematics>,
- ❖ <http://www.opensource.org>, www.mathpages.com

Mapping with Programme Outcomes: 3 Strong, 2- Medium, 1- Low

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	3	3	3	3
CO2	3	2	2	1	2	2	3	2	3
CO3	3	3	3	2	3	3	3	3	3
CO4	3	1	3	3	3	3	3	2	3
CO5	3	2	3	3	3	3	3	3	3
Weightage	15	11	14	12	14	14	15	13	15
Weighted percentage of Course Contribution to POs	3	2.2	2.8	2.4	2.8	2.8	3	2.6	3

Course Coordinator**BOS Chairman**

CORE IV – ADVANCED ALGEBRA

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S2PMA04	Core-IV	Theory	Y	Y	-	6	5

Learning Objectives :

- ❖ To study field extension, roots of polynomials, Galois Theory, finite fields, division rings, solvability by radicals and to develop computational skill in abstract algebra.

Course Learning Outcome (for Mapping with POs and PSOs)

Course Outcomes	On Completion of this course, students will:	Program Outcomes
CO1	Prove theorems applying algebraic ways of thinking.	PO1,PO3,PO5
CO2	Connect groups with graphs and understanding about Hamiltonian graphs.	PO3, PO5
CO3	Compose clear and accurate proofs using the concepts of Galois Theory.	PO1,PO3,PO6
CO4	Bring out insight into Abstract Algebra with focus on axiomatic theories.	PO3,PO5
CO5	Demonstrate knowledge and understanding of fundamental concepts including extension fields, Algebraic extensions, Finite fields, Class equations and Sylow's theorem.	PO4,PO5,PO6

CORE IV – ADVANCED ALGEBRA

Unit	Details	No. of Hours
I	Extension fields – Transcendence of e. Chapter 5: Section 5.1 and 5.2	18
II	Roots of Polynomials.- More about roots Chapter 5: Sections 5.3 and 5.5	18
III	Elements of Galois theory Chapter 5 : Section 5.6	18
IV	Finite fields - Wedderburn's theorem on finite division rings. Chapter 7: Sections 7.1 and 7.2 (Theorem 7.2.1 only)	18
V	Solvability by radicals - A theorem of Frobenius - Integral Quaternions and the Four *Self Study: Square theorem. Chapter 5: Section 5.7 (Lemma 5.7.1, Lemma 5.7.2 and Theorem 5.7.1) Chapter 7 : Sections 7.3 and 7.4	18
	Total	90
*Model preparation and Power Point Presentation – Related to the above topics are to be considered for Internal Exam only		

Text Books :

- ❖ I.N. Herstein. Topics in Algebra (II Edition) Wiley Eastern Limited, New Delhi, 1975.

Reference Books :

- ❖ M. Artin, Algebra, Prentice Hall of India, 1991.
- ❖ P.B. Bhattacharya, S.K. Jain, and S.R. Nagpaul, Basic Abstract Algebra (II Edition) Cambridge University Press, 1997. (Indian Edition)
- ❖ I.S. Luther and I.B.S. Passi, Algebra, Vol. I – Groups (1996); Vol. II
- ❖ Rings, Narosa Publishing House, New Delhi, 1999
- ❖ D.S. Malik, J.N. Mordeson and M.K. Sen, Fundamental of Abstract Algebra, McGraw Hill (International Edition), New York. 1997.
- ❖ 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

Mapping with Programme Outcomes: 3 Strong, 2- Medium, 1- Low

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	1	3	2	3	3	3	2	1
CO2	2	1	3	1	3	3	3	2	1
CO3	3	2	3	1	3	3	3	2	1
CO4	1	2	3	2	3	3	3	2	1
CO5	3	1	2	3	3	3	3	2	1
Weightage	12	7	14	9	15	15	15	10	5
Weighted percentage of Course Contribution to POs	2.4	1.4	2.8	1.8	3	3	3	2	1

Course Coordinator**BOS Chairman**

CORE V – REAL ANALYSIS II

Subject Code	Major	Category	L	T	P	Hours	Credit
24S2PMA05	Core – V	Theory	Y	Y	-	6	5

Learning Objectives :

- ❖ To introduce measure on the real line, Lebesgue measurability and integrability, Fourier Series and Integrals, in-depth study in multivariable calculus.

Course Learning Outcome (for Mapping with POs and PSOs)

Course Outcomes	On Completion of this course, students will:	Program Outcomes
CO1	Understand and describe the basic concepts of Fourier series and Fourier integrals with respect to orthogonal system.	PO1,PO3,PO5
CO2	Analyze the representation and convergence problems of Fourier series.	PO3, PO5,PO6
CO3	Analyze and evaluate the difference between transforms of various functions.	PO1,PO3,PO6
CO4	Formulate and evaluate complex contour integrals directly and by the fundamental theorem.	PO3,PO5,PO6
CO5	Apply the Cauchy integral theorem in its various versions to compute contour integration.	PO1,PO4,PO5

CORE V – REAL ANALYSIS II

Unit	Details	No. of Hours
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)	18
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)	18
III	Fourier Series and Fourier Integrals -Introduction - orthonormal system - Properties of Fourier Coefficients - The Riesz-Fischer Theorem - The convergence and representation problems in for trigonometric series - The Riemann - Lebesgue Lemma - The Dirichlet Integrals - An integral representation for the partial sums of Fourier series - Riemann's localization theorem - Sufficient conditions for convergence of a Fourier series at a particular point – Cesaro summability of Fourier series- Consequences of Fejes's theorem - The Weierstrass approximation theorem. Chapter 11 : Sections 11.1 to 11.15 (Apostol)	18
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)	18
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-. *Self Study: Extremum problems with side conditions Chapter 13 : Sections 13.1 to 13.7 (Apostol) *Field Visit : Optimize the layout of a solar panel field by finding the maxima of energy output based on variable angles of inclination and sunlight exposure.	18
	Total	90
*Model preparation and Power Point Presentation – Related to the above topics are to be considered for Internal Exam only		

Text Books :

- ❖ G. de Barra, Measure Theory and Integration, Wiley Eastern Ltd., New Delhi, 1981. (for Units I and II)
- ❖ Tom M. Apostol : Mathematical Analysis, 2nd Edition, Addison- Wesley Publishing Company Inc. New York, 1974. (for Units III, IV and V)

Reference Books :

- ❖ Burkill, J.C. The Lebesgue Integral, Cambridge University Press, 1951.
- ❖ Munroe, M.E. Measure and Integration. Addison-Wesley, Mass. 1971.
- ❖ Roydon, H.L. Real Analysis, Macmillan Pub. Company, New York, 1988.
- ❖ Rudin, W. Principles of Mathematical Analysis, McGraw Hill Company, New York, 1979.
- ❖ Malik, S.C. and Savita Arora. Mathematical Analysis, Wiley Eastern Limited. New Delhi, 1991.
- ❖ Sanjay Arora and Bansi Lal, Introduction to Real Analysis, Satya Prakashan, New Delhi,

Website and e-Learning Source :

- ❖ <http://mathforum.org>, <http://ocw.mit.edu/ocwwweb/Mathematics>,
- ❖ <http://www.opensource.org>

Mapping with Programme Outcomes: 3 Strong, 2- Medium, 1- Low

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	1	3	2	3	3	3	2	1
CO2	2	1	3	1	3	3	3	2	1
CO3	3	2	3	1	3	3	3	2	1
CO4	1	2	3	2	3	3	3	2	1
CO5	3	1	2	3	3	3	3	2	1
Weightage	12	7	14	9	15	15	15	10	5
Weighted percentage of Course Contribution to POs	2.4	1.4	2.8	1.8	3	3	3	2	1

Course Coordinator**BOS Chairman**

CORE VI – PARTIAL DIFFERENTIAL EQUATIONS

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S2PMA06	Core – VI	Theory	Y	Y	-	6	4

Learning Objectives

- ❖ To classify the second order partial differential equations and to study Cauchy problem, method of separation of variables, boundary value problems.

Course Learning Outcome (for Mapping with POs and PSOs)

Course Outcomes	On Completion of this course, students will:	Program Outcomes
CO1	To understand and classify second order equations and find general solutions	PO1, PO3, PO5
CO2	To analyse and solve wave equations in different polar coordinates	PO3, PO5, PO6
CO3	To solve Vibrating string problem, Heat conduction problem, to identify and solve Laplace and beam equations	PO1, PO5, PO6
CO4	To apply maximum and minimum principle's and solve Dirichlet, Neumann problems for various boundary conditions.	PO3, PO5
CO5	To apply Green's function and solve Dirichlet, Laplace problems, to apply Helmholtz operation and to solve Higher dimensional problem	PO1, PO4, PO6

CORE VI – PARTIAL DIFFERENTIAL EQUATIONS

Unit	Details	No. of Hours
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) *Model Preparation : Vibrating string	18
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	18
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)	18
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 *Activity: Model the temperature distribution in a rectangular metal plate with insulated sides and specified temperatures on the boundary.	18
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 . *Self Study: Neumann Problem. Chapter 10 : Section 10.1 to 10.9	18
	Total	90
*Model preparation and Power Point Presentation – Related to the above topics are to be considered for Internal Exam only		

Text Books :

- ❖ TynMyint-U and Lokenath Debnath, Partial Differential Equations for Scientists and Engineers (Third Edition), North Hollan, New York, 1987.

Reference Books :

- ❖ M.M.Smirnov, Second Order partial Differential Equations, Leningrad, 1964.
- ❖ I.N.Sneddon, Elements of Partial Differential Equations, McGraw Hill, New Delhi, 1983.
- ❖ R.Dennemeyer, Introduction to Partial Differential Equations and Boundary Value Problems, McGraw Hill, New York, 1968.
- ❖ M.D.Raisinghania, Advanced Differential Equations, S.Chand &Company Ltd., New Delhi, 2001.
- ❖ S, Sankar Rao, Partial Differential Equations, 2nd Edition, PrenticeHall 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

Mapping with Programme Outcomes: 3 Strong, 2- Medium, 1- Low

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	1	2	3	4	5	6	1	2	3
CO2	3	1	3	2	3	3	3	2	1
CO3	2	1	3	1	3	3	3	2	1
CO4	3	2	3	1	3	3	3	2	1
CO5	1	2	3	2	3	3	3	2	1
Weightage	10	8	15	10	17	18	13	10	7
Weighted percentage of Course Contribution toPOs	2	1.6	3	2	3.4	3.6	2.6	2	1.4

Course Coordinator

BOS Chairman

ELECTIVE III– ALGEBRAIC TOPOLOGY

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S2PMAE09	Elective - III	Theory	Y	Y	-	4	3

Learning Objectives

- ❖ To introduce the ideas of algebraic topology to other branches of Mathematics

Course Learning Outcome (for Mapping with POs and PSOs)

Course Outcomes	On Completion of this course, students will:	Program Outcomes
CO1	To understand and classify second order equations and find general solutions	PO1, PO3, PO5
CO2	To analyse and solve wave equations in different polar coordinates	PO1, PO3, PO6
CO3	To solve Vibrating string problem, Heat conduction problem, to identify and solve Laplace and beam equations	PO2, PO3, PO5
CO4	To apply maximum and minimum principle's and solve Dirichlet, Neumann problems for various boundary conditions.	PO1, PO3, PO4
CO5	To apply Green's function and solve Dirichlet, Laplace problems, to apply Helmholtz operation and to solve Higher dimensional problem.	PO3, PO4, PO6

ELECTIVE III– ALGEBRAIC TOPOLOGY

Unit	Details	No. of Hours
I	Calculus In The Plane: Path Integrals Angles and Deformations - Differential forms and path Integrals - Independence of Path - Criterion for exactness. Angles and Deformations: Angle functions and Winding numbers - Reparametrizing and Deforming the Paths. Winding Numbers. Definition - Homotopy and Reparametrization - Varying the Point - Degrees and Local Degrees. Chapter 1 : (a) to (c); Chapter 2: only (a) and (b) Chapter 3 : (a) to (d)	12
II	Cohomology And Homology De Rham Cohomology and the Jordan Curve Theorem. Definition of the De Rham Graphs - The Coboundary map - the Jordan Curve Theorem - Applications and Variations. Homology: Chains, Cycles, and H_0U - Boundaries, H_1U , and Winding Numbers - Chains on Grids - Maps and Homology - The First Homology Group for General Spaces. Chapter 5: (a) to (d) Chapter 6: (a) to (e)	12
III	Holes And Integrals Multiply connected regions - Integrations over continuous Paths and Chains - Periods of Integrals - Complex Integration Mayer-Victoris: The Boundary map - Mayer-Victoris for Homology - Variations and applications - Mayer- Victoris for Cohomology Chapter 9: (a) to (d) Chapter 10: (a) to (d)	12
IV	Covering Spaces And Fundamental Groups Covering Spaces: Definition - Lifting paths and Homotopies - G-coverings - Covering Transformations. The Fundamental Groups: Definitions and Basic Properties - Homotopy - Fundamental Group and Homology. Fundamental Groups and Covering Spaces: Fundamental Group and Coverings - Automorphisms of Coverings - The Universal Covering *Self Study: Coverings and Subgroups of the Fundamental Group. Chapter 11 : (a) to (d) Chapter 12 : (a) to (c) Chapter 13: (a) to (d)	12
V	The Van Kampen Theorem G-Coverings from the Universal Covering - Patching Coverings together - The Van Kampen Theorem Cohomology: Patching Coverings and Cech cohomology - Cech Cohomology and Homology - De Rham Cohomology and Homology -Proof of Mayer -Victoris for De Rham Cohomology. Chapter 14 : (a) to (d) ; Chapter 15: (a) to (d)	12
	Total	60
*Model preparation and Power Point Presentation – Related to the above topics are to be considered for Internal Exam only		

Text Books :

- ❖ William Fulton, Algebraic Topology - A First Course, Springer-Verlag, New York, 1995

Reference Books :

- ❖ M.K. Agoston, Algebraic topology- A First Course, Marcel Dekker, 1962
- ❖ Satya Deo, Algebraic Topology, Hindustan Book Agency, New Delhi, 2003.
- ❖ M. Greenberg and Harper, Algebraic Topology-A First course, Benjamin/Cummings, 1981.
- ❖ C.F. Maunder, Algebraic topology, Van Nostrand, New York, 1970
- ❖ J.R. Munkres, Topology, Prentice Hall of India, New Delhi, 2002 (3rd Indian Print)

Website and e-Learning Source :

- ❖ <http://mathforum.org>, <http://ocw.mit.edu/ocwweb/Mathematics>,
- ❖ <http://www.opensource.org>, www.mathpages.com

Mapping with Programme Outcomes: 3 Strong, 2- Medium, 1- Low

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	3	3	3	3
CO2	3	2	2	1	2	2	3	2	3
CO3	3	3	3	2	3	3	3	3	3
CO4	3	1	3	3	3	3	3	2	3
CO5	3	2	3	3	3	3	3	3	3
Weightage	15	11	14	12	14	14	15	13	15
Weighted percentage of Course Contribution to POs	3	2.2	2.8	2.4	2.8	2.8	3	2.6	3

Course Coordinator**BOS Chairman**

ELECTIVE IV– MATHEMATICAL STATISTICS

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S2PMAE10	Elective - IV	Theory	Y	Y	-	4	3

Learning Objectives :

- ❖ To understand probability concepts, including axioms, combinatorics, and Bayes' theorem, to analyze events and calculate probabilities in finite sample spaces and focusing on discrete and continuous distributions, moments, and generating functions.

Course Learning Outcome (for Mapping with POs and PSOs)

Course Outcomes	On Completion of this course, students will:	Program Outcomes
CO1	Demonstrate a thorough understanding of probability principles, including axioms, combinatorial methods, and Bayes' theorem, to compute probabilities and analyze the independence of events.	PO1,PO2,PO3
CO2	Analyze the moments of a distribution function to summarize data characteristics, and apply generating functions to simplify complex probability problems.	PO1, PO3,PO6
CO3	Evaluate multiple random variables and their joint distributions, understanding the implications of independence and functions of several random variables.	PO1,PO3,PO5
CO4	Compute and interpret covariance, correlation, and moments to assess the relationships between random variables, and understand the role of conditional expectation in probability theory.	PO3,PO4
CO5	Understand and apply the modes of convergence, including the weak and strong laws of large numbers, to analyze the behavior of sequences of random variables.	PO3,PO4,PO6

ELECTIVE IV – MATHEMATICAL STATISTICS

Unit	Details	No. of Hours
I	Probability and Random Variables: Probability – Axioms – Combinatorics, Probability on finite sample spaces – Conditional probability and Baye's theorem - Independence of events – Random variables – Probability distribution of a random variable – Discrete and continuous random variables * Self Study: Function of a random variable. (Chapter 1: Sections 1.3 to 1.6 and Chapter 2: Sections 2.2 to 2.5) *Activity: Track the amount spent on groceries each week. Students can model the distribution of weekly spending to forecast future expenses	12
II	Moments and Generating Functions: Moments of a distribution function – Generating functions – Some moment inequalities. (Chapter 3: Sections 3.2 to 3.4)	12
III	Multiple Random Variables: Multiple random variables Independent random variables – Functions of several random variables. (Chapter 4: Sections 4.2 to 4.4)	12
IV	Multiple Random Variables (Contd.): Covariance, Correlation and moments – Conditional expectation – Some discrete distributions – Some continuous distributions. (Chapter 4: Sections 4.5 and 4.6 and Chapter 5: Sections 5.2 to 5.3)	12
V	Limit Theorems: Modes of convergence – Weak law of large numbers – Strong law of large numbers – Central limit theorems.(Chapter 6: Sections 6.2 to 6.4 and 6.6)	12
	Total	60
*Model preparation and Power Point Presentation – Related to the above topics are to be considered for Internal Exam only		

Text Books :

- ❖ V.K. Rohatgi and A. K. MD Ehsanes Saleh An introduction to probability and Statistics, John WileyPvt, Singapore, 2001.

Referece Books :

- ❖ G.G. Roussas, A First Course in Mathematical Statistics, Addition Wesley Publ. Co. Mass, 1973
- ❖ M. Fisz, Probability Theory and Mathematical Statistics, John Wiley, New York, 1963.
- ❖ E.J. Dudewisg and S.N. Mishra, Modern Mathematical Statistics, John Wiley, New York, 1988

Website and e-Learning Source :

- ❖ <http://mathforum.org>,
- ❖ <http://ocw.mit.edu/ocwwweb/Mathematics>,
- ❖ <http://www.opensource.org>,
- ❖ www.mathpages.com

Mapping with Programme Outcomes: 3 Strong, 2- Medium, 1- Low

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	3	3	3	3
CO2	3	2	2	1	2	2	3	2	3
CO3	3	3	3	2	3	3	3	3	3
CO4	3	1	3	3	3	3	3	2	3
CO5	3	2	3	3	3	3	3	3	3
Weightage	15	11	14	12	14	14	15	13	15
Weighted percentage of Course Contribution to POs	3	2.2	2.8	2.4	2.8	2.8	3	2.6	3

Course Coordinator**BOS Chairman**

ELECTIVE III – STATISTICAL DATA ANALYSIS USING R-PROGRAMMING

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S2PMAE11	Elective - III	Theory	Y	Y	-	4	3

Learning Objectives :

- ❖ To gain proficiency in using R programming for comprehensive data analysis, including data manipulation, visualization, and statistical modeling.

Course Learning Outcome (for Mapping with POs and PSOs)

Course Outcomes	On Completion of this course, students will:	Program Outcomes
CO1	Understand the fundamentals of R programming, including installation, R Studio environment, and basic operations, enabling efficient navigation and utilization of the software for data analysis.	PO1,PO2,PO3
CO2	Develop skills in creating and manipulating various data structures such as vectors, data frames, and factors in R to organize and manage data efficiently.	PO1, PO5,PO6
CO3	Create and customize scatter plots, box plots, and other graphical representations in R to visually explore and communicate data patterns and relationships.	PO2,PO3,PO5
CO4	Calculate and interpret measures of central tendency, variability, skewness, and kurtosis using R to summarize and describe data distributions effectively.	PO3,PO4,PO5
CO5	Apply various statistical tests such as t-tests, chi-square tests, and ANOVA in R to validate hypotheses and assess relationships between variables, supporting rigorous data analysis	PO1,PO4,PO6

ELECTIVE III – STATISTICAL DATA ANALYSIS USING R-PROGRAMMING

Unit	Details	No. of Hours
I	Introduction to R programming: What is R? - Installing R and R Studio – R Studio Overview - Working in the Console - Arithmetic Operators – Logical Operations - Using Functions - Getting Help in R and Quitting R Studio- Installing and loading packages. Data structures, variables, and data types in R: Creating Variables - Numeric, Character and Logical Data - Vectors - Data Frames - Factors -Sorting Numeric, Character, and Factor Vectors - Special Values.	12
II	Data Visualization using R: Scatter Plots - Box Plots - Scatter Plots and Box- and-Whisker Plots Together -Customize plot axes, labels, add legends, and add colours.	12
III	Descriptive statistics in R: Measures of central tendency - Measures of variability - Skewness and kurtosis - Summary functions, describe functions, and descriptive statistics by group.	12
IV	Testing of Hypothesis using R: T-test, Paired Test, correlation, Chi-Square test, Analysis of Variance and Correlation	12
V	Predictive Analytics: linear Regression model, Non-Linear Least Square, multiple regression analysis, Logistic Regression, Panel Regression Analysis, ARCH Model, GARCH models. *Self Study: VIF Model.	12
	Total	60
*Model preparation and Power Point Presentation – Related to the above topics are to be considered for Internal Exam only		

Text Books :

- ❖ Crawley, M. J. (2006), —Statistics - An introduction using R, John Wiley, London 32.
- ❖ Purohit, S.G.; Gore, S.D. and Deshmukh, S.R. (2015), —Statistics using R, second edition. Narosa Publishing House, New Delhi.
- ❖ Shahababa B. (2011), —Biostatistics with R, Springer, New York.
- ❖ Braun & Murdoch (2007), —A first course in statistical programming with R, Cambridge University Press, New Delhi

Website and e-Learning Source :

- ❖ <https://cran.r-project.org/doc/contrib/Owen-TheRGuide.pdf>
- ❖ <https://sphweb.bumc.bu.edu/otlt/MPH-Modules/BS/R/R-Manual/R-Manual2.html>
- ❖ <https://smac-group.github.io/ds/>
- ❖ <https://www.geeksforgeeks.org/predictive-analysis-in-r>

Mapping with Programme Outcomes: 3 Strong, 2- Medium, 1- Low

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	3	3	3	3
CO2	3	2	2	1	2	2	3	2	3
CO3	3	3	3	2	3	3	3	3	3
CO4	3	1	3	3	3	3	3	2	3
CO5	3	2	3	3	3	3	3	3	3
Weightage	15	11	14	12	14	14	15	13	15
Weighted percentage of Course Contribution to POs	3	2.2	2.8	2.4	2.8	2.8	3	2.6	3

Course Coordinator

BOS Chairman

ELECTIVE III- TENSOR ANALYSIS AND RELATIVITY THEORY

Subject Code	Subject	Category	L	T	P	HOURS	Credit
24S2PMAE12	Elective - III	Theory	Y	Y	-	4	3

Learning Objectives

- ❖ The course aims to introduce vector algebra and vector calculus and special relativity and relativistic kinematics, dynamics and accelerated systems.

Course Learning Outcome (for Mapping with POs and PSOs)

Course Outcomes	On Completion of this course, students will:	Program Outcomes
CO1	Understanding covariant and contravariant vectors, and applying tensor operations such as outer multiplication and contraction.	PO1,PO2,PO3
CO2	Demonstrate proficiency in the algebraic properties of tensors, including equality, symmetric and skew-symmetric tensors, and operations	PO1, PO5,PO6
CO3	Understand Riemannian spaces and Christoffel symbols, and perform covariant differentiation of tensors, exploring the Riemann-Christoffel curvature tensor and its intrinsic differentiation properties	PO2,PO3,PO5
CO4	Applying Lorentz transformations to study relativistic kinematics, time dilation, and the relativistic Doppler effect.	PO1,PO3,PO4
CO5	Investigate momentum-energy relationships through four-vectors, explore forces and conservation laws in relativistic contexts, and apply Lagrangian and Hamiltonian formulations	PO1,PO4,PO6

ELECTIVE III- TENSOR ANALYSIS AND RELATIVITY THEORY

Unit	Details	No. of Hours
I	TENSOR ALGEBRA: Systems of Different orders - Summation Convention - Kronecker Symbols - Transformation of coordinates in S_n - Invariants - Covariant and Contravariant vectors - Tensors of Second Order - Mixed Tensors - Zero Tensor - Tensor Field Algebra of Tensors - Equality of Tensors - Symmetric and Skew – symmetric tensors - Outer multiplication, Contraction and Inner Multiplication - Quotient Law of Tensors - Reciprocal Tensor of Tensor Relative Tensor - Cross Product of Vectors. Chapter I : I.1 - I.3, I.7 and I.8 and Chapter II : II.1 - II.19	12
II	TENSOR CALCULUS: Riemannian Space - Christoffel Symbols and their properties Chapter III: III.1 and III.2.	12
III	TENSOR CALCULUS (CONTD): Covariant Differentiation of Tensors - Riemann - Christoffel Curvature Tensor - Intrinsic Differentiation. Chapter III: III.3 - III.5	12
IV	SPECIAL THEORY OF RELATIVITY :Galilean Transformation - Maxwell's equations - The ether Theory - The Principle of Relativity. Relativistic Kinematics : Lorentz Transformation equations - Events and simultaneity - Example - Einstein Train - Time dilation - Longitudinal Contraction - Invariant Interval - Proper time and Proper distance - World line - Example - twin paradox - addition of velocities * Self Study: Relativistic Doppler effect. Chapter 7 : Sections 7.1 and 7.2	12
V	RELATIVISTIC DYNAMICS: Momentum - Energy - Momentum - energy four vector - Force - Conservation of Energy - Mass and energy - Example - inelastic collision - Principle of equivalence - Lagrangian and Hamiltonian formulations. Accelerated Systems : Rocket with constant acceleration - example - Rocket with constant thrust . Chapter 7 : Sections 7.3 and 7.4	12
	Total	60
*Model preparation and Power Point Presentation – Related to the above topics are to be considered for Internal Exam only		

Text Books :

- ❖ U.C. De, Absos Ali Shaikh and Joydeep Sengupta, Tensor Calculus, Narosa Publishing House, New Delhi, 2004.
- ❖ D. Greenwood, Classical Dynamics, Prentice Hall of India, New Delhi, 1985.

Reference Books :

- ❖ J.L.Synge and A.Schild, Tensor Calculus, Toronto, 1949.
- ❖ A.S.Eddington. The Mathematical Theory of Relativity, Cambridge University Press, 1930.
- P.G.Bergman, An Introduction to Theory of Relativity, New York, 1942
- ❖ C.E.Weatherburn, Riemannian Geometry and the Tensor Calculus, Cambridge, 1938.

Website and e-Learning Source :

- ❖ <http://mathforum.org>, <http://ocw.mit.edu/ocwweb/Mathematics>,
- ❖ <http://www.opensource.org>, www.mathpages.com

Mapping with Programme Outcomes: 3 Strong, 2- Medium, 1- Low

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	3	3	3	3
CO2	3	2	2	1	2	2	3	2	3
CO3	3	3	3	2	3	3	3	3	3
CO4	3	1	3	3	3	3	3	2	3
CO5	3	2	3	3	3	3	3	3	3
Weightage	15	11	14	12	14	14	15	13	15
Weighted percentage of Course Contribution to POs	3	2.2	2.8	2.4	2.8	2.8	3	2.6	3

Course Coordinator**BOS Chairman**

ELECTIVE IV - WAVELETS

Subject Code	Subject	Category	L	T	P	HOURS	Credit
24S2PMAE13	ELECTIVE IV	Theory	Y	Y	-	4	3

Learning Objectives

- ❖ To know about wavelet transformation and Fourier transformations Wavelet series and Fourier series, Cardinal splinespaces and its properties, functions and wavelets and Cardinal spline wavelets.

Course Learning Outcome (for Mapping with POs and PSOs)

Course Outcomes	On Completion of this course, students will:	Program Outcomes
CO1	Determine integral wavelet transform, Fourier and inverse Fourier Transformation	PO1,PO5
CO2	Explain the concepts of Fourier and Wavelet series and their properties	PO2, PO4
CO3	Understand about the spline and interpolation formula	PO1,PO3,PO5
CO4	Analyze about the multi resolution analysis	PO3,PO4
CO5	Determine about computation of cardinal spline Wavelets	PO1,PO3

ELECTIVE IV - WAVELETS

Unit	Details	No. of Hours
I	An Overview : Fourier to Wavelets – Integral Wavelets Transform and Time frequency analysis – Inversion formulas and duals – Classification of Wavelets – Multiresolution analysis – Spines and Wavelets. Fourier Analysis : Fourier and Inverse Fourier Transformation – Continuous Time Convolution – The delta function – Fourier Transformation of square Integrable functions	12
II	Fourier Analysis (contd): Fourier Series – Basic Convergence Theory – Poisson Summation Formula. Wavelet Transforms and Time Frequency Analysis : The Gabor Transforms –Short time Fourier Transforms and the uncertainty principle – The integral Wavelet Transform –Dyadic Wavelets –Inversion –Frames –Wavelet Series.	12
III	Cardinal Spline Analysis : Cardinal Spline spaces –B-splines and their basic properties – The time scale relation and an interpolating graphical display algorithm – B-Net representations and computation of cardinal splines – Constructions of cardinal splines – constructions of spline application formulas –Construction of Spline interpolation Formulas	12
IV	Functions and Wavelets : Multi-resolution analysis –Scaling functions with finite two scale relation – Direction sum Decompositions of $L^2(R)$ - Wavelets and their duals	12
V	Cardinal Splines Wavelets : Interpolating splines wavelets Compactly supported spline – Wavelets – Computation of Cardinal spline Wavelets – Euler – Frebenious Polynomials(12 hours). Orthogonal Wavelets : Examples of orthogonal Wavelets – Identification of orthogonal two scale symbols *Self Study: Construction of compactly supported orthogonal wavelets.	12
	Total	60
*Model preparation and Power Point Presentation – Related to the above topics are to be considered for Internal Exam only		

Text Books :

- ❖ Content and Treatment as in Charles K. Chui, An introduction to Wavelets, Academic Press, New York, 1992.

Reference Books :

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

Website and e-Learning Source :

- ❖ <https://archive.nptel.ac.in/courses/108/101/108101093/>
- ❖ https://onlinecourses.nptel.ac.in/noc23_ee32/preview

Mapping with Programme Outcomes: 3 Strong, 2- Medium, 1- Low

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	1	2	2	3	2	3	3	2
CO2	2	3	2	3	2	2	3	3	2
CO3	3	3	3	3	3	2	3	3	3
CO4	3	2	3	3	2	2	3	3	2
CO5	3	2	3	3	2	2	3	2	3
Weightage	14	11	13	14	12	10	15	14	12
Weighted percentage of Course Contribution to POs	2.8	2.2	2.6	2.8	2.4	2	3	2.8	2.4

Course Coordinator**BOS Chairman**

ELECTIVE IV - MODELING AND SIMULATION WITH EXCEL

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S2PMAE14	Elective IV	Theory	Y	Y	-	4	3

Learning Objectives

- ❖ To know about wavelet transformation and Fourier transformations Wavelet series and Fourier series, Cardinal spline spaces and its properties, functions and wavelets and Cardinal spline wavelets.

Course Learning Outcome (for Mapping with POs and PSOs)

Course Outcomes	On Completion of this course, students will:	Program Outcomes
CO1	Understand the classification of models and the fundamental components of deterministic modeling to develop a structured approach to model building.	PO1,PO5
CO2	Construct basic models and perform sensitivity analysis using Excel	PO2, PO4
CO3	Apply simulation techniques, including Monte Carlo methods and analyze complex systems using Excel functions.	PO1,PO4,PO6
CO4	Develop and refine an income statement model in Excel	PO1,PO3,PO4
CO5	Apply Excel's Solver for constrained optimization in practical scenarios like York River Archaeology budgeting.	PO1,PO3

ELECTIVE IV - MODELING AND SIMULATION WITH EXCEL

Unit	Details	No. of Hours
I	Introduction- How Do We Classify Models? - An Example of Deterministic Modeling -Understanding the Important Elements of a Model	12
II	Model Building with Excel - Basic Model - Sensitivity Analysis - Controls from the Forms Control Tools- Scroll Bars.	12
III	Modeling and Simulation: Types of Simulation and Uncertainty - Incorporating Uncertain Processes in Models - The Monte Carlo Sampling Methodology-Implementing Monte Carlo Simulation Methods-A Word About Probability Distributions -Modeling Arrivals with the Poisson Distribution-VLOOKUP and HLOOKUP Functions.	12
IV	A Financial Example—Income Statement -An Operations Example—Autohaus -Status of Autohaus Model -Building the Brain Worksheet - Building the Calculation Worksheet-Variation in Approaches toPoisson Arrivals *Self Study: Consideration of Modeling Accuracy.	12
V	Sufficient Sample Size - Building the Data Collection Worksheet – Solver-Constrained Optimization -Example—York RiverArchaeology Budgeting –Scenarios.	12
	Total	60
*Model preparation and Power Point Presentation – Related to the above topics are to be considered for Internal Exam only		

Text Books :

- ❖ Hector Guerrero , Excel Data Analysis Modeling and Simulation, Springer Heidelberg Dordrecht London New York.

Website and e-Learning Source :

- ❖ <http://mathforum.org>, <http://ocw.mit.edu/ocwweb/Mathematics>,
- ❖ <http://www.opensource.org>, www.mathpages.com

Mapping with Programme Outcomes: 3 Strong, 2- Medium, 1- Low

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	1	2	2	3	2	3	3	2
CO2	2	3	2	3	2	2	3	3	2
CO3	3	3	3	3	3	2	3	3	3
CO4	3	2	3	3	2	2	3	3	2
CO5	3	2	3	3	3	3	3	3	3
Weightage	14	11	13	14	13	11	15	15	12
Weighted percentage of Course Contribution to POs	2.8	2.2	2.6	2.8	2.6	2.2	3	3	2.4

Course Coordinator**BOS Chairman**

ELECTIVE IV - MACHINE LEARNING AND ARTIFICIAL INTELLIGENCE

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S2PMAE15	Elective IV	Theory	Y	Y	-	4	3

Learning Objectives

- ❖ To Learn about Machine Intelligence and Machine Learning applications
- ❖ To implement and apply machine learning algorithms to real-world applications.
- ❖ To identify and apply the appropriate machine learning technique to classification, pattern recognition, optimization and decision problems. To understand how to perform evaluation of learning algorithms and model selection.
- ❖ To understand about the basic theory of problem solving paradigms and search strategies in artificial intelligence
- ❖ To make the students familiar with knowledge representation, planning, learning, natural language processing and robotics

Course Learning Outcome (for Mapping with POs and PSOs)

Course Outcomes	On Completion of this course, students will:	Program Outcomes
CO1	Have a good understanding of the fundamental issues and challenges of machine learning: data, model selection, model complexity, etc	PO1,PO5
CO2	Have an understanding of the strengths and weaknesses of many popular machine learning approaches	PO2, PO4
CO3	Appreciate the underlying mathematical relationships within and across Machine Learning algorithms and the paradigms of supervised and unsupervised learning	PO1,PO4,PO6
CO4	Be able to design and implement various machine learning algorithms in a range of real-world applications Understand the computation intelligence	PO1,PO3,PO4
CO5	Apply basic principles of AI in solutions that require problem solving, inference, perception, knowledge representation, and learning	PO1,PO3

ELECTIVE IV - MACHINE LEARNING AND ARTIFICIAL INTELLIGENCE

Unit	Details	No. of Hours
I	Introduction: Learning Problems – Perspectives and Issues – Concept Learning – Version Spaces and Candidate Eliminations – Inductive bias – Decision Tree learning – Representation – Algorithm– Heuristic Space Search.	12
II	Neural networks and genetic Algorithms: Neural Network Representation – Problems – Perceptrons – Multilayer Networks and Back Propagation Algorithms– Advanced Topics – Genetic Algorithms– Hypothesis Space Search – Genetic programming –Models of Evaluation and Learning.	12
III	Bayesian and computational learning: Bayes Theorem – Concept Learning – Maximum Likelihood – Minimum Description Length Principle – Bayes Optimal Classifier – Gibbs Algorithm – Naïve Bayes Classifier –Bayesian Belief Network – EM Algorithm – Probability Learning – Sample Complexity –Finite and Infinite Hypothesis Spaces – Mistake Bound Model.	12
IV	Introduction - Intelligent Agents- Problem Solving - by Searching - Informed Search Strategies-Optimization Problems - Adversarial Search-Knowledge and Reasoning - Logical Agents - First-Order Logic - Inference in First-Order Logic - Knowledge Representation	12
V	Planning – Planning and Acting in the Real World - Uncertain knowledge and reasoning - Uncertainty - Probabilistic Reasoning - Probabilistic Reasoning over Time - Making Simple Decisions. *Self Study: Making Complex Decisions	12
	Total	60
*Model preparation and Power Point Presentation – Related to the above topics are to be considered for Internal Exam only		

Text Books :

- ❖ Tom M. Mitchell,—Machine Learning, McGraw-Hill Education (India) Private Limited, 2013
- ❖ Stuart Russell, Peter Norvig, "Artificial Intelligence: A Modern Approach," Third Edition, Prentice Hall of India, New Delhi, 2010.

Reference Books :

- ❖ Ethem Alpaydin,—Introduction to Machine Learning (Adaptive Computation and Machine Learning), The MIT Press 2004.
- ❖ Stephen Marsland,—Machine Learning: An Algorithmic Perspective, CRC Press, 2009.
- ❖ Michael Affenzeller, Stephan Winkler, Stefan Wagner, Andreas Beham, —Genetic Algorithms and Genetic Programming, CRC Press Taylor and Francis Group.
- ❖ Elaine Rich, Kevin Knight, B. Nair, "Artificial Intelligence," Third Edition, Tata McGraw-Hill, New Delhi, 2017.
- ❖ Eugene Charniak, Drew McDermott, "Introduction to Artificial Intelligence," Pearson, 2002.

Website and e-Learning Source :

- ❖ <http://mathforum.org>,
- ❖ <http://ocw.mit.edu/ocwweb/Mathematics>,
- ❖ <http://www.opensource.org>, www.mathpages.com

Mapping with Programme Outcomes: 3 Strong, 2- Medium, 1- Low

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	2	2	2	2	2	3	3	2
CO2	2	1	2	1	3	2	3	3	3
CO3	3	2	2	2	2	3	2	2	2
CO4	2	2	2	2	2	2	3	2	2
CO5	3	1	2	2	3	3	2	2	2
Weightage	13	8	10	9	12	12	13	12	11
Weighted percentage of Course Contribution to Pos	2.6	1.6	2	1.8	2.4	2.4	2.6	2.4	2.2

Course Coordinator

BOS Chairman

ELECTIVE IV – NEURAL NETWORKS

Subject Code	Elective	Category	L	T	P	Hours	Credit
24S2PMAE16	Elective - IV	Theory	Y	Y	-	4	3

Learning Objectives :

- ❖ To know the main fundamental principles and techniques of neural network systems and investigate the principal neural network models and applications. Acquire in-depth knowledge in Nonlinear dynamics. Apply neural network to classification and generalization problems.

Course Learning Outcome (for Mapping with POs and PSOs)

Course Outcomes	On Completion of this course, students will:	Program Outcomes
CO1	Understand and analyze different neuron network models	PO1,PO3
CO2	Understand the basic ideas behind most common learning algorithms for multilayer perceptions, radial basis function networks.	PO5
CO3	Describe Hebb rule and analyze back propagation algorithms with examples.	PO1,PO6
CO4	Study convergence and generalization and implement common learning algorithms.	PO2,PO6
CO5	Study directional derivatives and necessary conditions for optimality and to evaluate quadratic functions.	PO1,PO5,PO6

ELECTIVE IV – NEURAL NETWORKS

Unit	Details	No. of Hours
I	Neuron Model and Network Architectures: Mathematical Neural Model- Network Architectures – Perceptron - Hamming Network-Hopfield Network-Learning Rules.	12
II	Perceptron Architectures: Perceptron Architectures and Learning Rules with proof of convergence-Supervised Hebbian Learning- Linear Associator.	12
III	Supervised Hebbian Learning: The Hebb Rule-Pseudo inverse rule- Variation of Hebbian Learning- Back Propagation-Multilayer Perceptrons.	12
IV	Back Propagation: Back Propagation algorithm-convergence and Generalization- Performances surfaces and optimum points-Taylor series.	12
V	Performance surface and performance optimizations: Directional derivatives- Minima-Necessary conditions for optimality – Quadratic functions - Performance optimizations. * Self Study: Steepest Descent Newton's method - Conjugate Gradient	12
	Total	60
*Model preparation and Power Point Presentation – Related to the above topics are to be considered for Internal Exam only		

Text Books :

- ❖ Martin T. Hagan, Howard B/Demuth and Mark Beale, Neural Network Design, Vikas Publishing House, New Delhi, 2002

Reference Books :

- ❖ James A.Freeman, David M.Skapura, Neural Networks Algorithms, Applications and Programming Techniques, Pearson Education, 2003.
- ❖ Robert J. Schalkoff, Artificial Neural Network, McGraw-Hill International Edition, 1997.

Website and e-Learning Source :

- ❖ <https://nptel.ac.in/courses/117105084>
- ❖ <https://www.digimat.in/nptel/courses/video/127105006/L01.html>
- ❖ https://www.youtube.com/watch?v=NeMAxhDvSak&list=PLgMDNELGJ1CZn1399dV7_U4VBNJflRsua
- ❖ <https://www.youtube.com/watch?v=QlhHqMnd9Wo>

Mapping with Programme Outcomes: 3 Strong, 2- Medium, 1- Low

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	2	2	2	2	2	3	3	2
CO2	2	1	2	1	3	2	3	3	3
CO3	3	2	2	2	2	3	2	2	2
CO4	2	2	2	2	2	2	3	2	2
CO5	3	1	2	2	3	3	2	2	2
Weightage	13	8	10	9	12	12	13	12	11
Weighted percentage of Course Contribution to POs	2.6	1.6	2	1.8	2.4	2.4	2.6	2.4	2.2

Course Coordinator**BOS Chairman**

SECOND YEAR - SEMESTER III

CORE VII: COMPLEX ANALYSIS

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S3PMA07	Core-VII	Theory	Y	-	-	6	5

Learning Objective:

- ❖ To Study Cauchy integral formula, local properties of analytic functions, general form of Cauchy's theorem evaluation of definite integral and harmonic functions.

Course Outcomes		
Course Outcomes	On completion of this course, students will able to	Programme Outcomes
CO1	Analyze and evaluate local properties of analytical functions and definite integrals.	PO1,PO2,PO4
CO2	Describe the concept of definite integral and harmonic functions.	PO2,PO4
CO3	Demonstrate the concept of the general form of Cauchy's theorem	PO1,PO3,PO6
CO4	Develop Taylor and Laurent series .	PO2,PO5,PO6
CO5	Explain the infinite products, canonical products and jensen's formula .	PO4

CORE VII: COMPLEX ANALYSIS

Unit	Details	No. of Hours
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-Taylor's Theorem – Zeros and poles – The local Mapping – The Maximum Principle. Chapter 4 : Section 2 : 2.1 to 2.3 Chapter 4 : Section 3 : 3.1 to 3.4	18
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	18
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	18
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	18
V	Partial Fractions and Entire Functions : Partial fractions - Infinite products – Canonical products - Self Study: Gamma Function. Jensen's formula-Hadamard's theorem. Chapter 5 : Sections 2.1 to 2.4 Chapter 5 : Sections 3.1 and 3.2	18
	Total	90
* Model preparation and Power Point Presentation – Related to the above topics are to be considered for Internal Exam only		

Text book:

- ❖ Lars V. Ahlfors, Complex Analysis, (3rd edition) McGraw Hill Co., New York, 1979.

Reference books:

- ❖ H.A. Presfly, Introduction to complex Analysis, Clarendon Press, Oxford, 1990.
- ❖ J.B. Conway, Functions of one complex variables Springer -Verlag, International student Edition, Naroser Publishing Co. 1978
- ❖ E. Hille, Analytic function Thorey (2 vols.), Gonm & Co, 1959.
- ❖ M. Heins, Complex function Theory, Academic Press, New York, 1968.

Web Resources:

- ❖ <http://mathforum.org>, <http://ocw.mit.edu/ocwwweb/Mathematics>,
- ❖ <http://www.opensource.org>, <http://en.wikipedia.org>

Mapping with Programme Outcomes : 3 Strong, 2 – Medium, 1 – Low

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	1	3	2	3	3	3	2	1
CO2	2	1	3	1	3	3	3	2	1
CO3	3	2	3	1	3	3	3	2	1
CO4	1	2	3	2	3	3	3	2	1
CO5	3	1	2	3	3	3	3	2	1
Weightage	12	7	14	9	15	15	15	10	5
Weighted percentage of Course contribution to PO's	2.4	1.4	2.8	1.8	3	3	3	2	1

Course Coordinator**BOS Chairman**

CORE VIII: PROBABILITY THEORY

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S3PMA08	Core-VIII	Theory	Y	-	-	6	5

Learning Objectives:

- ❖ To introduce axiomatic approach to probability theory to study some statistical characteristics, discrete and continuous distribution functions and their properties, characteristic function and basic limit theorems of probability.

Course Outcomes		
Course Outcomes	On completion of this course, students will able to	Programme Outcomes
CO1	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.	PO1,PO2,PO3
CO2	To define Expectation, Moments and Chebyshev Inequality, to solve Regression of the first and second types.	PO2,PO3
CO3	To define Characteristic functions, to define distribution function, to find probability generating functions, to solve problems applying characteristic functions	PO4,PO6
CO4	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	PO5
CO5	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.	PO2,PO4,PO6

CORE VIII: PROBABILITY THEORY

Unit	Details	No. of Hours
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	18
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	18
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	18
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)	18
V	Limit Theorems : Stochastic convergence – Bernaulli law of large numbers – Convergence of sequence of distribution functions – Levy-Cramer Theorems – de Moivre-Laplace Theorem – Poisson, Chebyshev, Khintchine Weak law of large numbers – Lindberg Theorem – Lapunov Theroem – Borel-Cantelli Lemma Self study : 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)	18
	Total	90
* Model preparation and Power Point Presentation – Related to the above topics are to be considered for Internal Exam only		

Text book:

- ❖ M. Fisz, Probability Theory and Mathematical Statistics, John Wiley and Sons, New York, 1963.

Reference books:

- ❖ R.B. Ash, Real Analysis and Probability, Academic Press, New York, 1972
- ❖ K.L.Chung, A course in Probability, Academic Press, New York, 1974.
- ❖ R.Durrett, Probability : Theory and Examples, (2nd Edition) Duxbury Press, New York, 1996.
- ❖ V.K.Rohatgi An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern Ltd., New Delhi, 1988(3rdPrint).
- ❖ S.I.Resnick, A Probability Path, Birhauser, Berlin, 1999.
- ❖ B.R.Bhat , Modern Probability Theory (3rd Edition), New Age International (P)Ltd, New Delhi, 1999

Web Resources:

- ❖ <http://mathforum.org>, <http://ocw.mit.edu/ocwweb/Mathematics>,
- ❖ <http://www.opensource.org>, <http://www.probability.net>

Mapping with Programme Outcomes: 3 Strong, 2 – Medium, 1 – Low

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	1	3	2	3	3	3	2	1
CO2	2	1	3	1	3	3	3	2	1
CO3	3	2	3	1	3	3	3	2	1
CO4	1	2	3	2	3	3	3	2	1
CO5	3	1	2	3	3	3	3	2	1
Weightage	12	7	14	9	15	15	15	10	5
Weighted percentage of course Contributions to POs	2.4	1.4	2.8	1.8	3	3	3	2	1

Course Coordinator**BOS Chairman**

CORE IX: TOPOLOGY

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S3PMA09	CORE IX	Theory	Y	-	-	6	5

Learning Objectives:

- ❖ To study topological spaces, continuous functions, connectedness, compactness, countability and separation axioms.

Course Outcomes		
Course Outcomes	On completion of this course, students will able to	Programme Outcomes
CO1	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	PO1,PO3
CO2	Understand continuity, compactness, connectedness, homeomorphism and topological properties.	PO2,PO4
CO3	Analyze and apply the topological concepts in Functional Analysis.	PO1,PO3,PO6
CO4	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.	PO4,PO6
CO5	Develop qualitative tools to characterize connectedness, compactness, second countable, Hausdorff and develop tools to identify when two are equivalent (homeomorphic).	PO1,PO6

CORE IX: TOPOLOGY

Unit	Details	No. of Hours
I	Topological spaces : Topological spaces – Basis for a topology – The order topology – The product topology on $X \times Y$ – The subspace topology – Closed sets and limit points. Chapter 2 : Sections 12 to 17	18
II	Continuous functions: Continuous functions – the product topology – The metric topology. Chapter 2 : Sections 18 to 21 (Omit Section 22)	18
III	Connectedness: Connected spaces- connected subspaces of the Real line – Components and local connectedness. Chapter 3 : Sections 23 to 25.	18
IV	Compactness : Compact spaces – compact subspaces of the Real line – Limit Point Compactness – Local Compactness. Chapter 3 : Sections 26 to 29.	18
V	Countability and Separation Axiom: The Countability Axioms – The separation Axioms – Normal spaces – The Urysohn Lemma – The Urysohn metrization Theorem Self study : The Tietz extension theorem. Chapter 4 : Sections 30 to 35.	18
	Total	90
* Model preparation and Power Point Presentation – Related to the above topics are to be considered for Internal Exam only		

Text book:

- ❖ James R. Munkres, Topology (2nd Edition) Pearson Education Pvt Ltd., Delhi-2002 (Third Indian Reprint)

Reference books:

- ❖ J. Dugundji, Topology, Prentice Hall of India, New Delhi, 1975.
- ❖ George F. Simmons, Introduction to Topology and Modern Analysis, McGraw Hill Book Co., 1963
- ❖ J.L. Kelly, General Topology, Van Nostrand, Reinhold Co., New York
- ❖ L. Steen and J. Subhash, Counter Examples in Topology, Holt, Rinehart and Winston, New York, 1970.
- ❖ S. Willard, General Topology, Addison - Wesley, Mass., 1970

Web Resources:

- ❖ <http://mathforum.org>,
- ❖ <http://ocw.mit.edu/ocwwweb/Mathematics>,
- ❖ <http://www.opensource.org>,
- ❖ <http://en.wikipedia.org>

Mapping with Programme Outcomes: 3 Strong, 2 – Medium, 1 – Low

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	1	3	2	3	3	3	2	1
CO2	2	1	3	1	3	3	3	2	1
CO3	3	2	3	1	3	3	3	2	1
CO4	1	2	3	2	3	3	3	2	1
CO5	3	1	2	3	3	3	3	2	1
Weightage	12	7	14	9	15	15	15	10	5
Weighted percentage of course Contributions to POs	2.4	1.4	2.8	1.8	3	3	3	2	1

Course Coordinator**BOS Chairman**

CORE X: MACHINE LEARNING

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S3PMA10	CORE X	Theory	Y	-	-	6	4

Learning Objectives

- ❖ To learn about Machine intelligence and Machine Learning applications
- ❖ To implement and apply machine learning algorithms to real world applications.
- ❖ To understand the basic theory of problem solving paradigms and search strategies in artificial intelligence.

Course Outcomes		
Course Outcomes	On completion of this course, students will able to	Programme Outcomes
CO1	Define machine learning terms and types of machine learning techniques.	PO1,PO2,PO5
CO2	Explain the need for automation programming constructs in RPA. Introducing Robots and Soft bots	PO3,PO5
CO3	Learn Cloud Computing and define the Types of Cloud along the types of services	PO1,PO3,PO6
CO4	Understanding the term Cyber Security and its types	PO3,PO4
CO5	To Study the concept of virtual reality, Head Mounted Displays and its tools.	PO5,PO6

CORE X: MACHINE LEARNING

Unit	Details	No. of Hours
I	Machine Learning : Introduction -Definition –Types of Machine Learning -Supervised , Unsupervised ,Reinforcement Learning- Algorithms for Machine Learning – problems solved by Machine Learning – Tools for Machine Learning – Applications.	12
II	ROBOTIC PROCESS AUTOMATION(RPA) Robotic Process Automation(RPA): Introduction to RPA –Need for automation programming constructs in RPA- Robots and Softbots – RPA architecture and process methodologies –Industries best suited for RPA.	12
III	CLOUD Cloud Computing : Need-Definition –Types of Cloud -Types of services –Saas	12
IV	CYBER Cyber Security: Cyber Crime and Information security – Classification of cyber Crime Types.	12
V	VIRTUAL Virtual Reality: Definition- Types of Head Mounted Displays Self study : Tools for Reality	12
	Total	60
* Model preparation and Power Point Presentation – Related to the above topics are to be considered for Internal Exam only		

Text book:

- ❖ Higher Education for industry 4.0 and Transformation to Education 5.0
by P. Kaliraj and T. Devi

Reference Books:

- ❖ Ethem Alpaydin – Introduction to machine learning (Adaptive Computation and Machine Learning), The MIT Press, 2004.
- ❖ Tom M. Mitchell – Machine Learning, McGraw-Hill Education (India) Pvt. Ltd, 2013.
- ❖ Stephen Marsland – Machine Learning: An Algorithmic Perspective, CRC Press, 2009.

Web Resources:

- ❖ <http://mathforum.org>
- ❖ <http://ocw.mit.edu/ocwweb/Mathematics>,
- ❖ <http://www.opensource.org>, www.mathpages.com

Mapping with Programme Outcomes: 3 Strong, 2 – Medium, 1 – Low

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	1	3	2	3	3	3	2	1
CO2	2	1	3	1	3	3	3	2	1
CO3	3	2	3	1	3	3	3	2	1
CO4	1	2	3	2	3	3	3	2	1
CO5	3	1	2	3	3	3	3	2	1
Weightage	12	7	14	9	15	15	15	10	5
Weighted percentage of course Contributions to POs	2.4	1.4	2.8	1.8	3	3	3	2	1

Course Coordinator**BOS Chairman**

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

ELECTIVE V: ALGEBRAIC NUMBER THEORY

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S3PMAE17	Elective V	Theory	Y	-	-	3	3

Learning Objectives:

- ❖ To study the algebraic numbers ,number fields including their Galois group .
- ❖ To understand the role of ideals and class groups .

Course Outcomes		
Course Outcomes	On completion of this course, students will able to	Programme Outcomes
CO1	Define Rings and Fields including Field extensions, free abelian groups.	PO1, PO3
CO2	Illustrate the Conjugates and Discriminants, and properties of norms and Integers.	PO3
CO3	Identifying Quadratic fields and cyclotomic fields, Factorizing irreducibles and illustrate examples of non-unique factorization into irreducibles.	PO1, PO3
CO4	Explaining Prime Factorization and Euclidean Domains, Consequences of unique factorization	PO1, PO3
CO5	Gain knowledge about Prime Factorization of Ideals, Non-unique Factorization in Cyclotomic Fields..	PO1, PO3

ELECTIVE V: ALGEBRAIC NUMBER THEORY

Unit	Details	No. of Hours
I	ALGEBRAIC BACKGROUND Rings and Fields- Factorization of Polynomials - Field Extensions – Symmetric Polynomials - Modules - Free Abelian Groups. Chapter 1: Sec. 1.1 to 1.6	09
II	ALGEBRAIC NUMBERS Algebraic numbers – Conjugates and Discriminants - Algebraic Integers - Integral Bases - Norms and Traces - Rings of Integers. Chapters 2: Sec. 2.1 to 2.6	09
III	QUADRATIC AND CYCLOTOMIC FIELDS 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	09
IV	Prime Factorization - Euclidean Domains – Euclidean Quadratic fields - Consequences of unique factorization – The Ramanujan - Nagell Theorem. Chapter 4: Sec. 4.5 to 4.9	09
V	IDEALS Prime Factorization of Ideals - The norms of an Ideal Self study : Non-unique Factorization in Cyclotomic Fields.. Chapter 5 : Sec. 5.2 to 5.4	09
	Total	45
* Model preparation and Power Point Presentation – Related to the above topics are to be considered for Internal Exam only		

Text book:

- ❖ Steward and D.Tall. Algebraic Number Theory and Fermat's Last Theorem (3rd Edition) A.K.Peters Ltd., Natrick, Mass. 2002.

Reference Books

- ❖ Z.I.Bosevic and I.R.Safarevic, Number Theory, Academic Press, New York, 1966.
- ❖ J.W.S.Cassels and A.Frohlich, Algebraic Number Theory, Academic Press, New York 1967.
- ❖ P.Ribenboim, Algebraic Numbers, Wiley, New York, 1972.
- ❖ P. Samuel, Algebraic Theory of Numbers, Houghton Mifflin Company, Boston, 1970.
- ❖ A.Weil. Basic Number Theory, Springer, New York, 1967.

Web Resources:

- ❖ <http://mathforum.org>
- ❖ <http://ocw.mit.edu/ocwwweb/Mathematics>

Mapping with Programme Outcomes: 3 Strong, 2 – Medium, 1 – Low

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	3	3	2	3
CO2	3	3	3	3	2	2	3	2	3
CO3	3	3	3	2	3	2	3	3	3
CO4	2	1	3	3	3	3	3	2	3
CO5	3	3	2	3	3	3	3	3	3
Weightage	14	13	14	14	14	13	15	12	15
Weighted percentage of course contribution to PO's	2.8	2.6	2.8	2.8	2.8	2.6	3	2.4	3

Course Coordinator**BOS Chairman**

ELECTIVE V: FLUID DYNAMICS

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S3PMAE18	Elective V	Theory	Y	-	-	3	3

Learning Objectives:

- ❖ To understand the properties of fluids and fluid motion such as density , viscosity and surface tension.
- ❖ To implement and analyze the laminar and turbulent flow

Course Outcomes		
Course Outcomes	On completion of this course, students will able to	Programme Outcomes
CO1	Define the Real fluids and Ideal fluids and identify the Stream lines.	PO1, PO3
CO2	Differentiate the Pressure at a point in a fluid at rest and Pressure at a point in a moving fluid.	PO3,PO6
CO3	Find the Images in rigid infinite plane .	PO1, PO2
CO4	Discuss the Stream Function and the Complex Velocity Potential for Two Dimensional Irrotational.	PO1, PO5
CO5	Acquire deep knowledge about solvable problems in viscous flow and Steady motion between parallel planes .	PO1, PO4

ELECTIVE V: FLUID DYNAMICS

Unit	Details	No. of Hours
I	Kinematics of Fluids in Motion: Real fluids and Ideal fluids Velocity of a fluid at a point –Stream lines and path lines - Steady and Unsteady flows - The Velocity Potential - The Vorticity Vector - Local and Particle Rates of Change - The Equation of Continuity - Worked Examples. (Chapter 2: Sections 2.1 - 2.8).	09
II	Equations of Motion of a Fluid: Pressure at a point in a fluid at rest - Pressure at a point in a moving fluid - Euler's equations of Motion - Bernoulli's equation -Worked Examples - Discussion of the case of steady motion under Conservative Body Forces – Some flows involving axial symmetry(examples 1 and 2 only). (Chapters 3: Sections 3.1, 3.2,3.4 - 3.7, 3.9).	09
III	Some Three-Dimensional Flows: Introduction - Sources, Sinks and Doublets-Images in rigid infinite plane - Images in solid spheres – Axis symmetric flows. (Chapter 4: Sections 4.1 - 4.4).	09
IV	Some Two-Dimensional Flows: The Stream Function - The Complex Velocity Potential for Two Dimensional Irrotational, Incompressible Flow - Complex Velocity Potentials for Standard TwoDimensional Flows - Some Worked Examples - Two Dimensional Image Systems - The Milne-Thomson Circle Theorem. (Chapter 5: Sections 5.3 - 5.8).	09
V	Viscous Fluid: Stress components in a real fluid – Relation between Cartesian Components of Stress - Translational motion of fluid element – The Coefficient of Viscosity and Laminar flow – The Navier- Stokes equation of a viscous fluid - Some solvable problems in viscous flow Self study : Steady motion between parallel planes only. (Chapter 8: Sections 8.1 - 8.3, 8.8, 8.9 and 8.10.1).	09
	Total	45
* Model preparation and Power Point Presentation – Related to the above topics are to be considered for Internal Exam only.		

Text book:

- ❖ Frank Chorlton, Textbook of Fluid Dynamics, CBS Publishers & Distributors, 2004.

Reference books:

- ❖ L.M. Milne-Thomson, Theoretical Hydrodynamics, Macmillan, London, 1955.
- ❖ G.K. Batchelor, An Introduction to Fluid Dynamics Cambridge Mathematical Library, 2000.

Web Resources:

- ❖ <http://mathforum.org>
- ❖ <http://ocw.mit.edu/ocwweb/Mathematics>,
- ❖ <http://www.opensource.org>, www.mathpages.com

Mapping with Programme Outcomes: 3 Strong, 2 – Medium, 1 – Low

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	3	3	2	3
CO2	3	3	3	3	2	2	3	2	3
CO3	3	3	2	2	3	2	3	3	3
CO4	2	2	3	2	3	3	3	2	3
CO5	3	3	3	3	2	3	3	3	3
Weightage	14	14	14	13	13	13	15	12	15
Weighted percentage of course contribution to PO's	2.8	2.8	2.8	2.6	2.6	2.6	3	2.4	3

Course Coordinator**BOS Chairman**

ELECTIVE V: STOCHASTIC PROCESSES

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S3PMAE19	Elective V	Theory	Y	-	-	3	3

Learning Objectives:

- ❖ This course introduces the concept of stochastic process including its applications to queues and storage problems.
- ❖ To understand the stationary process and time series, wide sense and representation of Khintchine's wide sense stationary process.

Course Outcomes		
Course Outcomes	On completion of this course, students will able to	Programme Outcomes
CO1	Understand the stochastic process and its fundamentals	PO1, PO3
CO2	Master the basics of Discrete state space, random walk. and its application to queues and storage problem.	PO3
CO3	Apply the wiener process as a limit of random walk, first passage time Diffusion process with Wiener process.	PO1, PO3
CO4	Analyze and simplify the covariance function - Bochner's function.	PO1, PO3
CO5	Gain knowledge about the renewal theory ,renewal function and its properties .	PO1, PO3

ELECTIVE V: STOCHASTIC PROCESSES

Unit	Details	No. of Hours
I	Introduction to stochastic process (SP) – classification of SP according to state space and time domain. countable state Markov chain (MC). Chapman- Kolmogorov equations. Calculation of 'n' step transition probability.	9
II	Discrete state space – continuous time MC. Kolmogorov differential equations. Poisson process, birth and death process. Application to queues and storage problem. Random walk.	9
III	Markov process – continuous time and continuous state space - time homogenous markov process – Kolmogorov's equation. Wiener process as a limit of random walk, first passage time Diffusion process with Wiener process.	9
IV	Stationary process and time series- wide sense and strict sense stationary process – moving average and auto regressive process. Covariance function - Bochner's function (statement),Khintchine's representation of wide sense stationary process.	9
V	Renewal theory – renewal function and its properties Self study : Elementary and key renewal theorems.	9
	Total	45

Text books:

- ❖ Medhi.J. (1982) Stochastic process, Wiley Eastern.
- ❖ Basu. A.K. (2003) Introduction to stochastic processes, Newsa Publishing House

Reference books:

- ❖ Ross. S.M. (1983) Stochastic Process, Wiley, New York.
- ❖ Karlin and First course in Stochastic Process-Vol.I&II, Academic Press. Taylor.H.M. (1975)

Web Resources:

- ❖ <http://mathforum.org>
- ❖ <http://ocw.mit.edu/ocwwweb/Mathematics>,
- ❖ <http://www.opensource.org>,
- ❖ www.mathpages.com

Mapping with Programme Outcomes: 3 Strong, 2 – Medium, 1 – Low

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	1	3	2	3	3	3	2	1
CO2	2	2	3	1	3	2	3	2	1
CO3	3	2	3	2	3	3	3	3	1
CO4	1	2	3	2	3	3	3	2	1
CO5	3	1	2	3	3	3	3	2	1
Weightage	12	8	14	10	15	14	15	11	5
Weighted percentage of course contribution to PO's	2.4	1.6	2.8	2	3	2.8	3	2.2	1

Course Coordinator**BOS Chairman**

ELECTIVE V: PYTHON PROGRAMMING

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S3PMAE20	Elective V	Theory	Y	-	-	3	3

Learning Objectives:

- ❖ To enable students to develop algorithmic thinking and problem-solving skills through Python programming and its applications.

Course Outcomes		
Course Outcomes	On completion of this course, students will able to	Programme Outcomes
CO1	Understand the fundamental problem-solving strategies and tools like algorithm, flowchart, and pseudo code.	PO1,PO2
CO2	Apply iterative and recursive techniques to develop efficient algorithms for basic mathematical problems.	PO1 ,PO2 ,PO6
CO3	Comprehend the basics of Python programming including data types, variables, and operators.	PO1 PO4 PO6
CO4	Develop structured programs using functions, modules, conditionals, and loops in Python.	PO1,PO2,P05
CO5	Demonstrate the use of data structures like strings, lists, and tuples for real-world data processing.	PO1,PO2,PO6

ELECTIVE V: PYTHON PROGRAMMING

Unit	Details	No. of Hours
I	PROBLEM SOLVING TECHNIQUES: Problem solving Techniques – Algorithm, flowchart, pseudocode, programming; Algorithms: properties, quality (time, space); building blocks of algorithms - statements, state, control flow, functions, notation (pseudo code, flow chart, programming language)	9
II	ALGORITHMIC PROBLEM SOLVING: Algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion), pseudocode for some Mathematical Problems – greatest of two numbers, print n natural numbers, greatest common divisor, fibonacci sequence upto n terms. Practical applications of algorithms.	9
III	INTRODUCTION TO PYTHON: Introduction to Python, Python interpreter, Modes of Python Interpreter, Values and Data Types, Variables, Keywords, Identifiers, Statements and Expressions, Input and Output, Comments, Docstring, Lines and Indentation, Quotation, Tuple Assignment, Operators and Types of Operators, Operator Precedence.	9
IV	PYTHON FUNCTIONS: Functions, Types of function, Function definition (Sub program), Flow of Execution, Function Prototypes, Parameters and Arguments; Modules; Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion.	9
V	STRING, LISTS, TUPLES IN PYTHON: Strings: string slices, immutability, string functions and methods, string module; Lists as arrays. Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameter Self study : Tuples: tuple assignment, tuple as return value	9
	Total	45

Text book :

- ❖ Allen B. Dowley, Think Python: How to think like a computer Scientist, 2nd Edition

Reference Books:

- ❖ Wes McKinney, Python for Data Analysis: Data Wrangling with Pandas, NumPy, and Ipython, O'Reilly, 2nd Edition, 2018.
- ❖ Jake VanderPlas, Python Data Science Hand Book: Essential Tools for working with Data, O'Reilly, 2017.
- ❖ Wesley J. Chun, Core Python Programming, Prentice Hall, 2006.
- ❖ N.Safina Devi and C.Devamanoharan, Algorithmic Problem Solving and Python- A Beginner's Guide, Francidev Publications, 2023.

Web Resources:

- ❖ <http://mathforum.org>
- ❖ <http://ocw.mit.edu/ocwwweb/Mathematics>,
- ❖ <http://www.opensource.org>,
- ❖ www.mathpages.com

Mapping with Programme Outcomes: 3 Strong, 2 – Medium, 1 – Low

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	2	3	2	3	3	1	2	1
CO2	3	1	3	3	3	3	3	2	1
CO3	2	2	3	1	3	3	3	2	1
CO4	1	2	2	2	2	3	3	2	1
CO5	3	1	2	3	3	3	3	2	1
Weightage	12	8	13	11	14	15	13	10	5
Weighted percentage of course contribution to PO's	2.4	1.6	2.6	2.2	2.8	3	2.6	2	1

Course Coordinator**BOS Chairman**

SECOND YEAR - SEMESTER IV

CORE XI : FUNCTIONAL ANALYSIS

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S4PMA11	Core-XI	Theory	Y	-	-	6	5

Learning Objectives:

- ❖ To provide students with a strong foundation in functional analysis, focusing on spaces, operators and fundamental theorems. To develop student's skills and confidence in mathematical analysis and proof techniques.

Course Outcomes		
Course Outcomes	On completion of this course, students will able to	Programme Outcomes
CO1	Understand the Banach spaces and Transformations on Banach Spaces.	PO1,PO3,PO5
CO2	Prove Hahn Banach theorem and open mapping theorem	PO3,PO6
CO3	Describe operators and fundamental theorems.	PO1,PO3
CO4	Validate orthogonal and orthonormal sets.	PO3,PO5
CO5	Analyze and establish the regular and singular elements	PO1,PO4,PO5

CORE XI: FUNCTIONAL ANALYSIS

Unit	Details	No. of Hours
I	Banach Spaces: The definition and some examples – Continuous linear transformations – The Hahn-Banach theorem – The natural imbedding of N in N^{**} - The open mapping theorem – The conjugate of an Operator. Chapter 9:Sections 46-51	18
II	Hilbert Spaces: The definition and some simple properties– Orthogonal complements–Ortho normal sets–The conjugate space H^* -The adjoint of an operator–self-adjoint operators-Normal and unitary operators – Projections. Chapter10:Sections52-59	18
III	Finite-Dimensional Spectral Theory: Matrices – Determinants and the spectrum of an operator –The spectral theorem. Chapter 11:Sections 60-62	18
IV	General Preliminaries on Banach Algebras: The definition and some examples – Regular and singular elements – Topological divisors of zero – The spectrum – The formula for the spectral radius– The radical and semi-simplicity. Chapter 12:Sections 64-69	18
V	The Structure of Commutative Banach Algebras: The Gelfand mapping – Application of the formula – Involutions in Banach algebras Self study : The Gelfand-Neumark theorem. Chapter 13:Sections 70-73	18
	Total	90
* Model preparation and Power Point Presentation – Related to the above topics are to be considered for Internal Exam only		

Text book:

- ❖ G.F.Simmons, Introduction to Topology and Modern Analysis, McGraw Hill Education (India) Private Limited, New Delhi, 1963.

Reference books:

- ❖ W.Rudin, Functional Analysis, McGraw Hill Education (India) Private Limited, New Delhi, 1973.
- ❖ B.V. Limaye, Functional Analysis, New Age International, 1996.
- ❖ C. Goffman and G. Pedrick, First course in Functional Analysis, Prentice Hall of India, New Delhi, 1987.
- ❖ E. Kreyszig, Introductory Functional Analysis with Applications, John Wiley & Sons, New York, 1978.
- ❖ M. Thamban Nair, Functional Analysis, A First course, Prentice Hall of India, New Delhi, 2002.

Web Resources:

- ❖ <http://mathforum.org>,
- ❖ <http://ocw.mit.edu/ocwweb/Mathematics>,
- ❖ <http://www.opensource.org> , <http://en.wikipedia.org>

Mapping with Programme Outcomes: 3 Strong, 2 – Medium, 1 – Low

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO ₁	3	1	3	2	3	3	3	2	1
CO ₂	2	1	3	1	3	3	3	2	1
CO ₃	3	2	3	1	3	3	3	2	1
CO ₄	1	2	3	2	3	3	3	2	1
CO ₅	3	1	2	3	3	3	3	2	1
Weightage	12	7	14	9	15	15	15	10	5
Weighted percentage of Course contribution to PO's	2.4	1.4	2.8	1.8	3	3	3	2	1

Course Coordinator**BOS Chairman**

CORE XII: DIFFERENTIAL GEOMETRY

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S4PMA12	Core-XII	Theory	Y	-	-	6	5

Learning Objectives:

- ❖ 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 Outcomes		
Course Outcomes	On completion of this course, students will able to	Programme Outcomes
CO1	Explain space curves, Curves between surfaces, metrics on a surface, fundamental form of a surface and Geodesics.	PO1, PO2, PO6
CO2	Evaluate these concepts with related examples.	PO1, PO5, PO6
CO3	Compose problems on geodesics.	PO1, PO2, PO6
CO4	Recognize applicability of developable.	PO1, PO2, PO6
CO5	Construct and analyze the problems on curvature and minimal surfaces	PO3,PO5

CORE XII: DIFFERENTIAL GEOMETRY

Unit	Details	No. of Hours
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- Helices. Chapter I : Sections 1 to 9.	18
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.	18
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.	18
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.	18
V	Differential Geometry of Surfaces : Compact surfaces whose points are umbilics- Hilbert's lemma – Compact surface of constant curvature – Complete surface and their characterization – Hilbert's Theorem – Conjugate points on geodesics. Self Study: Geodesic mapping. Chapter IV : Sections 1 to 8 (Omit 9 to 15).	18
	Total	90
* Model preparation and Power Point Presentation – Related to the above topics are to be considered for Internal Exam only		

Text book:

- ❖ T.J.Willmore, An Introduction to Differential Geometry, Oxford University Press,(17th Impression) New Delhi 2002. (Indian Print)

Reference books:

- ❖ Struik, D.T. Lectures on Classical Differential Geometry, Addison – Wesley, Mass. 1950.
- ❖ Kobayashi. S. and Nomizu. K. Foundations of Differential Geometry, Inter science Publishers, 1963.
- ❖ Wilhelm Klingenberg: A course in Differential Geometry, Graduate Texts in Mathematics, Springer-Verlag 1978.
- ❖ J.A. Thorpe Elementary topics in Differential Geometry, Undergraduate Texts in Mathematics, Springer - Verlag 1979.

Web Resources:

- ❖ <http://mathforum.org>,
- ❖ <http://ocw.mit.edu/ocwwweb/Mathematics>
- ❖ <http://www.opensource.org>
- ❖ <http://en.wikipedia.org>

Mapping with Programme Outcomes: 3 Strong, 2 – Medium, 1 – Low

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	1	3	3	3	3	3	2	3
CO2	2	3	2	1	3	3	1	3	1
CO3	2	2	3	1	2	3	3	2	3
CO4	3	2	1	2	3	2	3	2	1
CO5	2	1	2	3	3	3	3	2	1
Weightage	12	9	11	10	14	14	13	11	9
Weighted percentage of Course contribution to PO1	2.4	1.8	2.2	2	2.8	2.8	2.6	2.2	1.8

Course Coordinator**BOS Chairman**

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

ELECTIVE VI: RESOURCE MANAGEMENT TECHNIQUES

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S4PMAE21	Elective VI	Theory	Y	-	-	4	3

Learning Objectives:

- ❖ Formulate linear programming models for various business scenarios.
- ❖ Evaluate investment decisions using first-order and second-order stochastic dominance principles.

Course Outcomes		
Course Outcomes	On completion of this course, students will able to	Programme Outcomes
CO1	Formulate and solve linear programming problems using graphical and simplex methods to optimize resource allocation.	PO1, PO2, PO6
CO2	Analyze dual problems and apply network models like transportation, assignment, and shortest route problems in real-life decision-making.	PO3
CO3	Apply integer programming techniques such as branch and bound and cutting plane methods to solve discrete optimization problems.	PO1, PO3
CO4	Demonstrate the ability to solve optimization problems using classical methods including Lagrangian and Kuhn–Tucker conditions	PO1, PO4
CO5	Design project schedules using CPM and analyze investment and risk using stochastic dominance and time charts	PO2, PO5

ELECTIVE VI: RESOURCE MANAGEMENT TECHNIQUES

Unit	Details	No. of Hours
I	LINEAR PROGRAMMING Principal components of decision problem – Modeling phases – LP Formulation and graphic solution –Resource allocation problems – Simple method – Sensitivity analysis.	12
II	DUALITY AND NETWORKS Definition of dual problem – Primal – Dual relationships – Dual simplex methods – Post optimality analysis – Transportation and assignment model - Shortest route problem.	12
III	INTEGER PROGRAMMING Cutting plan algorithm – Branch and bound methods, Multistage (Dynamic) programming.	12
IV	CLASSICAL OPTIMISATION THEORY Unconstrained external problems, Newton – Ralphson method – Equality constraints – Jacobean methods – Lagrangian method – Kuhn – Tucker conditions – Simple problems	12
V	OBJECT SCHEDULING Network diagram representation – Critical path method – Time charts Stochastic Order Relations First-Order Stochastic Dominance - Using Coupling to Show - Likelihood Ratio Ordering -A Single-Period Investment Problem-Second-Order Dominance. Self Study: Stochastic Dominance.	12
	Total	60
* Model preparation and Power Point Presentation – Related to the above topics are to be considered for Internal Exam only		

Text book:

- ❖ H.A. Taha, —Operation Research, Prentice Hall of India, 2002.

Reference Books:

- ❖ Paneer Selvam, _Operations Research_, Prentice Hall of India, 2002
- ❖ Anderson _Quantitative Methods for Business_, 8th Edition, Thomson Learning, 2002.
- ❖ Winston _Operation Research_, Thomson Learning, 2003.
- ❖ Vohra, _Quantitative Techniques in Management_, Tata Mc Graw Hill, 2002.
- ❖ Anand Sarma, _Operation Research_, Himalaya Publishing House, 2003

Web Resources:

- ❖ <http://mathforum.org>
- ❖ <http://ocw.mit.edu/ocwweb/Mathematics>

Mapping with Programme Outcomes: 3 Strong, 2 – Medium, 1 – Low

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	1	2	3	3	3	3	2	3
CO2	2	3	2	1	1	3	2	3	2
CO3	2	2	3	1	2	3	3	2	3
CO4	3	2	1	2	3	2	3	2	1
CO5	2	1	2	3	3	3	3	2	1
Weightage	12	9	10	10	12	14	14	11	10
Weighted percentage of course contribution to	2.4	1.8	2	2	2.4	2.8	2.8	2.2	2

Course Coordinator**BOS Chairman**

ELECTIVE VI: ALGEBRAIC GEOMETRY

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S4PMAE22	Elective VI	Theory	Y	-	-	4	3

Learning Objectives:

- ❖ This course introduces a higher level knowledge about projective spaces and sheafification of a presheaf
- ❖ This enables to understand prime spectrum and elementary dimensions.

Course Outcomes		
Course Outcomes	On completion of this course, students will able to	Programme Outcomes
CO1	Define Affine spaces and algebraic sets Noetherian rings, including affine algebraic sets as finite intersection of hyper surfaces.	PO1, PO2
CO2	Determine the decomposition of an algebraic set into irreducible components.	PO3
CO3	Design the Local properties of plane curves, Linear systems of curves, intersections of projective curves.	PO2, PO6
CO4	Illustrate the examples of Affine tangent spaces, Projective varieties and morphisms,	PO1, PO4
CO5	Study the elementary Dimension Theory and also analyze the fibres of a morphism, complete varieties, nonsingularity	PO2, PO3

ELECTIVE VI: ALGEBRAIC GEOMETRY

Unit	Details	No. of Hours
I	Affine algebraic sets : Affine spaces and algebraic sets, Noetherian rings, Hilbert basis theorem, affine algebraic sets as finite intersection of hypersurfaces; Ideal of a set of points, coordinate ring, morphism between algebraic sets, isomorphism. Integral extensions, Noether's normalization lemma	12
II	Hilbert's Nullstellensatz and applications Correspondence between radical ideals and algebraic sets, prime ideals and irreducible algebraic sets, maximal ideals and points, contrapositive equivalence between affine algebras with algebra homomorphisms and algebraic sets with morphisms, between affine domains and irreducible algebraic sets, decomposition of an algebraic set into irreducible components. Zariski topology on affine spaces, algebraic subsets of the plane.	12
III	Projective spaces: Homogeneous coordinates, hyperplane at infinity, projective algebraic sets, homogeneous ideals and projective Nullstellensatz; Zariski topology on projective spaces. Twisted cubic in $P_3(k)$. Local properties of plane curves: multiple points and tangent lines, multiplicity and local rings, intersection numbers; projective plane curves: Linear systems of curves, intersections of projective curves: Bezout's theorem and applications; group structure on a cubic.	12
IV	Introduction to sheaves of affine varieties: Examples of presheaves and sheaves, stalks, sheafification of a presheaf, sections, structure sheaf, generic stalk and function fields, rational functions and local rings, Affine tangent spaces; Projective varieties and morphisms; Hausdorff axiom.	12
V	Prime spectrum of a ring: Zariski topology, structure sheaf, affine schemes, morphism of affine schemes. Elementary Dimension Theory, Fibres of a morphism, complete varieties, nonsingularity and regular local rings, Jacobian criterion Self study : Nonsingular curves and DVR's	12
	Total	60
* Model preparation and Power Point Presentation – Related to the above topics are to be considered for Internal Exam only		

Text books:

- ❖ W.Fulton Algebraic Curves: An introduction to algebraic geometry
- ❖ C. G. Gibson – Elementary Geometry of Algebraic Curves, CUP,
- ❖ D. S. Dummitt and R. M. Foote – Abstract Algebra, Wiley, Ch. 15.

Reference Books:

- ❖ J. Harris Algebraic Geometry, A first course, Springer
- ❖ M. Reid Undergraduate algebraic geometry, LMS 12, CUP
- ❖ K. Kendig – Elementary Algebraic Geometry, Springer
- ❖ D. Mumford – The Red Book of Varieties and Schemes, Springer
- ❖ I. R. Shafarevich – Basic Algebraic Geometry, Springer.

Web Resources:

- ❖ <http://mathforum.org>
- ❖ <http://ocw.mit.edu/ocwweb/Mathematics>,

Mapping with Programme Outcomes: 3 Strong, 2 – Medium, 1 – Low

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	1	2	3	3	3	1	2	3
CO2	2	3	3	2	1	1	2	3	2
CO3	2	2	3	1	2	3	3	2	1
CO4	3	2	1	2	1	1	3	2	1
CO5	2	3	2	3	1	3	3	2	1
Weightage	12	11	11	11	8	11	12	11	8
Weighted percentage of course contribution to PO's	2.4	2.2	2.2	2.2	1.6	2.2	2.4	2.2	1.6

Course Coordinator**BOS Chairman**

ELECTIVE VI: FINANCIAL MATHEMATICS

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S4PMAE23	Elective VI	Theory	Y	-	-	4	3

Learning Objectives:

- ❖ In this course, the students are on posed to The basic concepts of Probability theory, The Central limit theorem.
- ❖ The concepts of Geometric Brownian motion, Option pricing.
- ❖ The derivatives of Blackschole formula and its applications.
- ❖ The concept of call option on Dividend paying securities, estimating the volatility parameter.
- ❖ The limitations of Arbitrage pricing, the portfolio selection problem.

Course Outcomes		
Course Outcomes	On completion of this course, students will able to	Programme Outcomes
CO1	Understand and apply concepts of stochastic dominance and likelihood ratio ordering in financial decision-making.	PO1, PO3
CO2	Formulate and solve deterministic and probabilistic optimization models for business problems.	PO3
CO3	Analyze and solve stochastic dynamic programming problems, including optimal stopping and infinite-time models.	PO1, PO3
CO4	Apply simulation techniques to price exotic options and develop efficient simulation estimators.	PO1, PO4
CO5	Model financial assets beyond standard Geometric Brownian Motion assumptions using real-world data.	PO4, PO5

ELECTIVE VI: FINANCIAL MATHEMATICS

Unit	Details	No. of Hours
I	Stochastic Order Relations First-Order Stochastic Dominance -Using Coupling to Show Stochastic Dominance - Likelihood Ratio Ordering -A Single-Period Investment Problem-Second-Order Dominance. .	12
II	Optimization Models Introduction- A Deterministic Optimization Model –Probabilistic Optimization Problems	12
III	Stochastic Dynamic Programming The Stochastic Dynamic Programming Problem - Infinite Time Models - Optimal Stopping Problems	12
IV	Exotic Options Introduction -Barrier Options - Asian and Lookback Options – Monte Carlo Simulation -Pricing Exotic Options by Simulation – More Efficient Simulation Estimators	12
V	Beyond Geometric Brownian Motion Models Introduction -Crude Oil Data - Models for the Crude Oil Data Self study : Final Comments	12
	Total	60
* Model preparation and Power Point Presentation – Related to the above topics are to be considered for Internal Exam only		

Text Book :

- ❖ An Elementary Introduction to Mathematical Finance, 2nd Edition Sheldon M. Ross
Cambridge University press 2005

Reference Books:

- ❖ A First Course in Probability, S.M. Ross, Englewood cliffs Prentice Hall NJ 2002
- ❖ Option Market, J. Cox M. Rubinstein, Englewood cliffs Prentice Hall NJ 1985
- ❖ Theory of Financial decision Making, J.E. Ingersill, Lanjarn MD Rowerman of Little Fields 1987

Web Resources:

- ❖ <http://mathforum.org>
- ❖ <http://ocw.mit.edu/ocwweb/Mathematics>,

Mapping with Programme Outcomes: 3 Strong, 2 – Medium, 1 – Low

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	2	2	3	3	3	1	1	3
CO2	2	3	2	2	2	1	2	3	2
CO3	2	2	3	1	2	3	2	3	1
CO4	3	2	1	2	1	1	3	2	1
CO5	2	3	2	3	1	3	3	2	1
Weightage	12	12	10	11	9	11	11	11	8
Weighted percentage of course contribution to PO's	2.4	2.4	2	2.2	1.8	2.2	2.2	2.2	1.6

Course Coordinator**BOS Chairman**

ELECTIVE VI: MATHEMATICAL PYTHON

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S4PMAE24	Elective VI	Theory	Y	-	-	4	3

Learning Objectives

- ❖ To demonstrate Problem Solving Techniques, Algorithmic Problem Solving , Understanding of basic Python and Python functions in mathematical problem solving.

Course Outcomes		
Course Outcomes	On completion of this course, students will able to	Programme Outcomes
CO1	Understand and apply basic problem-solving techniques like algorithms, flowcharts, and pseudo code.	PO1,PO2,PO4
CO2	Develop and implement algorithmic solutions using iterative and recursive approaches	PO3
CO3	Explain and apply fundamental concepts of Python programming language.	PO1, PO2,PO6
CO4	Develop Python programs using functions, modules, conditionals, and iterations effectively.	PO1, PO5,PO6
CO5	Manipulate strings, lists, and tuples in Python for solving computational problems.	PO1, PO6

ELECTIVE VI: MATHEMATICAL PYTHON

Unit	Details	No. of Hours
I	PROBLEM SOLVING TECHNIQUES: Problem solving Techniques – Algorithm, flowchart, pseudocode, programming; Algorithms: properties, quality (time, space); building blocks of algorithms - statements, state, control flow, functions, notation (pseudo code, flow chart, programming language)	12
II	ALGORITHMIC PROBLEM SOLVING: Algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion), pseudocode for some Mathematical Problems – greatest of two numbers, print n natural numbers, greatest common divisor, fibonacci sequence upto n terms. Practical applications of algorithms.	12
III	INTRODUCTION TO PYTHON: Introduction to Python, Python interpreter, Modes of Python Interpreter, Values and Data Types, Variables, Keywords, Identifiers, Statements and Expressions, Input and Output, Comments, Docstring, Lines and Indentation, Quotation, Tuple Assignment, Operators and Types of Operators, Operator Precedence	12
IV	PYTHON FUNCTIONS: Functions, Types of function, Function definition (Sub program), Flow of Execution, Function Prototypes, Parameters and Arguments; Modules; Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion.	12
V	STRING, LISTS, TUPLES IN PYTHON: Strings: string slices, immutability, string functions and methods, string module; Lists as arrays. Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameter Self study : Tuples: tuple assignment, tuple as return value.	12
	Total	60
* Model preparation and Power Point Presentation – Related to the above topics are to be considered for Internal Exam only		

Text book :

- ❖ Allen B. Dowley, Think Python: How to Think Like a Computer Scientist, 2nd Edition

Reference Books:

- ❖ Wes McKinney, Python for Data Analysis: Data Wrangling with Pandas, NumPy, and Ipython, O'Reilly, 2nd Edition, 2018.
- ❖ Jake VanderPlas, Python Data Science Hand Book: Essential Tools for working with Data, O'Reilly, 2017.
- ❖ Wesley J. Chun, Core Python Programming, Prentice Hall, 2006.
- ❖ N.Safina Devi and C.Devamanoharan, Algorithmic Problem Solving and Python- A Beginner's Guide, Francidev Publications, 2023.

Web Resources:

- ❖ <http://mathforum.org>
- ❖ <http://ocw.mit.edu/ocwwweb/Mathematics>,
- ❖ <http://www.opensource.org>
- ❖ www.mathpages.com

Mapping with Programme Outcomes: 3 Strong, 2 – Medium, 1 – Low

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	2	3	3	3	1	1	3
CO2	2	3	2	2	3	1	2	3	2
CO3	2	2	3	1	2	3	2	3	1
CO4	3	2	2	2	1	1	3	2	1
CO5	2	3	2	3	1	3	3	2	1
Weightage	12	13	11	11	10	11	11	11	8
Weighted percentage of course contribution to PO's	2.4	2.6	2.2	2.2	2	2.2	2.2	2.2	1.6

Course Coordinator**BOS Chairman**

SEC : RESEARCH TOOLS AND TECHNIQUES

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S4PMAS01	SEC	Theory	Y	-	-	4	2

Learning Objectives

- ❖ To enable students to develop strong research skills, from problem identification to data analysis and interpretation, fostering decision-making abilities, ethical research conduct, communication, and leadership in research-oriented environments.

Course Outcomes		
Course Outcomes	On completion of this course, students will able to	Programme Outcomes
CO1	Understand the research process and develop effective research designs.	PO1,PO2
CO2	Identify and classify research problems, variables, and their types.	PO2,PO3
CO3	Formulate hypotheses, apply sampling techniques, and select appropriate data collection tools.	PO1, PO3,PO6
CO4	Analyze and interpret collected research data accurately.	PO4, PO5
CO5	Differentiate and apply appropriate research methods like descriptive, survey, and experimental methods.	PO2, PO6

SEC : RESEARCH TOOLS AND TECHNIQUES

Unit	Details	No. of Hours
I	Research Process- Research Design	12
II	Research Problem-Variables and Their Types	12
III	Formulation of Hypothesis– Sampling- Tools of Data Collection	12
IV	Data Analysis- Interpretation of Data	12
V	Research Methods - Descriptive or Survey Method Self study : Experimental Method	12
	Total	60
* Model preparation and Power Point Presentation – Related to the above topics are to be considered for Internal Exam only		

Text Book :

- ❖ Research Methodology: Tools And Techniques Dr.Prabhat Pandey Dr. Meenu Mishra Pandey © Bridge Center, 2015

Reference Books:

- ❖ Ackoff, Russell L. (1961). The Design of Social Research, University of Chicago Press: Chicago.
- ❖ Allen, T. Harrell, (1978). New Methods in Social Research, Praeger Publication: New York.
- ❖ Baker, R.P. & Howell, A.C. (1958). The Preparation of Reports, Ronald Press:New York.
- ❖ Barzun, Jacques & Graff. F. (1990).The Modern Researcher, Harcourt, Brace Publication: New York.
- ❖ Berelson Conard & Colton, Raymond. (1978). Research and Report Writing for Business and Economics, Random House: New York.

Web Resources:

- ❖ <http://mathforum.org>
- ❖ <http://ocw.mit.edu/ocwwweb/Mathematics>,
- ❖ <http://www.opensource.org>
- ❖ www.mathpages.com

Mapping with Programme Outcomes: 3 Strong, 2 – Medium, 1 – Low

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	3	3	3	3
CO2	3	2	2	1	2	2	3	2	3
CO3	3	3	3	2	3	3	3	3	3
CO4	3	1	3	3	3	3	3	2	3
CO5	3	2	3	3	3	3	3	3	3
Weightage	15	11	14	12	14	14	15	13	15
Weighted percentage of course contribution to PO's	3	2.2	2.8	2.4	2.8	2.8	3	2.6	3

Course Coordinator

BOS Chairman

SEC I: MATHEMATICAL COMPUTATION WITH SAGEMATH

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S4PMAS02	SEC	Theory	Y	-	-	4	2

Learning Objectives

- ❖ To demonstrate Problem Solving Techniques, Algorithmic Problem Solving, Understanding of basic Python and Python functions in mathematical problem solving.

Course Outcomes		
Course Outcomes	On completion of this course, students will able to	Programme Outcomes
CO1	Understand the basics of the Sage program and perform basic calculations.	PO1, PO3
CO2	Solve symbolic expressions, simplify equations, and perform basic linear algebra using Sage	PO3
CO3	Develop skills in algorithmic programming and data structures using Sage.	PO1, PO3
CO4	Create 2D and 3D graphics and visualize mathematical data using Sage.	PO1, PO3
CO5	Understand and work with computational domains, object-oriented elements, and expressions in Sage.	PO1, PO3

SEC : MATHEMATICAL COMPUTATION WITH SAGEMATH

Unit	Details	No. of Hours
I	First Steps The Sage Program -Sage as a Calculator	12
II	Analysis and Algebra Symbolic Expressions and Simplification – Equations – Analysis - Basic Linear Algebra	12
III	Programming and Data Structures Syntax –Algorithmics -Lists and Other Data Structures	12
IV	Graphics 2D Graphics - 3D Curves	12
V	Computational Domains Sage is Object-Oriented- Elements, Parents, Categories-Domains with a Normal Form Self study : Expressions vs Computational Domains	12
	Total	60
* Model preparation and Power Point Presentation – Related to the above topics are to be considered for Internal Exam only		

Text book :

- ❖ Mathematical Computation with SageMath, Paul Zimmermann Alexandre Casamayou.

Reference Books:

- ❖ Uri M. Ascher and Linda R. Petzold, Computer Methods for Ordinary Differential Equations and Differential-Algebraic Equations. Society for Industrial and Applied Mathematics, 1998, ISBN 0898714128.
- ❖ Noga Alon and Joel H. Spencer, The Probabilistic Method. Wiley- Interscience, 2000, ISBN 0471370460.
- ❖ Bernard Beauzamy, Robust mathematical methods for extremely rare events. On-line, 2009.

Web Resources:

- ❖ <http://mathforum.org>
- ❖ <http://ocw.mit.edu/ocwwweb/Mathematics>,
- ❖ <http://www.opensource.org>
- ❖ www.mathpages.com

Mapping with Programme Outcomes: 3 Strong, 2 – Medium, 1 – Low

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	3	3	3	3
CO2	3	2	2	1	2	2	3	2	3
CO3	3	3	3	2	3	3	3	3	3
CO4	3	1	3	3	3	2	3	2	3
CO5	3	2	3	3	3	3	2	3	3
Weightage	15	11	14	12	14	13	14	13	15
Weighted percentage of course contribution to PO's	3	2.2	2.8	2.4	2.8	2.6	2.8	2.6	3

Course Coordinator**BOS Chairman**

SEC : ADVANCED LATEX

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S4PMAS03	SEC	Theory	Y	-	-	4	2

Learning Objectives:

- ❖ To create understanding of the LaTeX
- ❖ To typeset typical mathematical papers using the article style and figure out LaTeX errors, download and use packages, create simple diagrams.
- ❖ To prepare a short presentation using the beamer class.

Course Outcomes		
Course Outcomes	On completion of this course, students will able to	Programme Outcomes
CO1	Understand the structure of a LaTeX document, installation, and common LaTeX environments and commands.	PO1, PO2, PO6
CO2	Master display and alignment structures for equations, and compare LaTeX methods with standard formats.	PO2, PO3
CO3	Learn how to insert and manipulate figures, images, and graphics using LaTeX and related packages.	PO1, PO4
CO4	Understand and apply LaTeX overlays, themes, and tools for assignments and exams, including charts and random numbers.	PO3, PO6
CO5	Structure a LaTeX document effectively, including sections, cross-referencing, bibliography, page styles, and multilingual support.	PO1, PO5

SEC : ADVANCED LATEX

Unit	Details	No. of Hours
I	Introduction and the Structure of a LaTeX Document Installation of the software LaTeX - Environments and commands -Classes and packages – Errors - Files created - How to use LAEX at CUED - Document Classes - Arara- Counters and Length parameters -Document and page organization – Page breaks, footnotes. Environments , Matrix-like environments . Chapter - 1 and 2 in I & Chapter - 1 in II ; Chapter – 4 in I & Chapter – 5 in II; Chapter -8 (Section 8.3) in III.	12
II	Display and alignment structures : Display and alignment structures for equations Comparison with standard LaTeX - A single equation on one line - A single equation on several lines: no alignment - A Single equation on several lines: with alignment - Equation groups without alignment – Equation groups with simple alignment- Multiple alignments: align and flalign - Display environments as mini-pages- Interrupting displays, Variable symbol commands - Symbols in formulas Chapter – 8 (Section 8.2, 8.5, 8.6 and 8.9) in III	12
III	Figures Directly in LaTeX : Inserting Images, Positioning Images, List of Figures, Drawing diagrams directly in LaTeX, TikZ package, Graphics and PSTricks Pictures and graphics in LaTeX, simple pictures using PSTricks, Plotting of functions	12
IV	Overlays -Themes Assignments and Examinations The exam Class - The exsheets Package - The probsoln Package - Using the data tool Package for Exams or Assignment Sheets - Random Numbers. Charts Flow Charts - Pie Charts - The datapie Package - The pgf-pie Package - Bar Charts - The bchart Package - The databar Package - Gantt Charts - Plots . Chapter – 8, 9 and 12 in II .	12
V	Structuring Your Document: Author and Title Information, Abstract, Chapters, Sections, Subsections, Creating a Table of Contents, Cross-Referencing, Creating a Bibliography, Page Styles and Page Numbering Self study : Multi- Lingual Support: using the babel package. (5.1-5.7)	12
	Total	60
* Model preparation and Power Point Presentation – Related to the above topics are to be considered for Internal Exam only		

Text books :

- ❖ Advanced LATEX by Tim Love, 2006
- ❖ http://www.h.eng.cam.ac.uk/help/documentation/docsource/latex_advanced.pdf
- ❖ LaTeX for Administrative Work by Nicola L. C. Talbot, Dickimaw Books, 2015, <http://www.dickimaw-books.com/latex/admin/>
- ❖ The LaTeX Companion by Frank Mittelbach and Michel Goossens, Addison-Wesley, Library of Congress Cataloging-in-Publication Data (Second Edition)
- ❖ V.Nicola L. C. Talbot, LATEX for Complete Novices Version 1.4, Dickimaw Books <http://www.dickimaw-books.com/2012>.

Reference Books:

- ❖ Bindner, Donald & Erickson, Martin. (2011). A Student's Guide to the Study, Practice, and Tools of Modern Mathematics. CRC Press, Taylor & Francis Group, LLC.
- ❖ Lamport, Leslie (1994). LaTeX: A Document Preparation System, User's Guide and Reference Manual (2nd ed.). Pearson Education. Indian Reprint.
- ❖ George Gratzer, More Math into LATEX, 4th Edition, 2007 Springer Science.
- ❖ A Primer, Latex, Tutorials, Indian TEX users group, Trivandrum, India. www.tug.org.in

Web Resources:

- ❖ <http://mathforum.org>
- ❖ <http://ocw.mit.edu/ocwwweb/Mathematics>,
- ❖ <http://www.opensource.org>
- ❖ www.mathpages.com

Mapping with Programme Outcomes: 3 Strong, 2 – Medium, 1 – Low

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	3	3	3	3
CO2	3	2	2	1	2	2	3	2	3
CO3	3	3	3	2	3	3	3	3	3
CO4	3	1	3	3	3	3	3	2	3
CO5	3	2	3	3	3	3	3	3	3
Weightage	15	11	14	12	14	14	15	13	15
Weighted percentage of course contribution to PO's	3	2.2	2.8	2.4	2.8	2.8	3	2.6	3

Course Coordinator**BOS Chairman**

SEC : OFFICE AUTOMATION AND ITC TOOLS

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S4PMAS04	SEC	Theory	Y	-	-	4	2

Learning Objectives:

- ❖ To Learn how to effectively use productivity software such as Microsoft Office Suite .
Understand the concept of reprographics and its role in modern office environments

Course Outcomes		
Course Outcomes	On completion of this course, students will able to	Programme Outcomes
CO1	Understand the concept and importance of office automation, and identify different tools for office automation	PO1, PO4
CO2	Learn the functionalities of computer mail systems, telecommunication systems, and word processing (WP) hardware configurations	PO2,PO5
CO3	Illustrate the WP hardware techniques and its types	PO4, PO5
CO4	Gain knowledge about reprographics, electronic mail, electronic filing systems, and facsimile transmission	PO2, PO6
CO5	Explore voice technology and its application in office automation and communication.	PO1, PO3,PO6

SEC : OFFICE AUTOMATION AND ICT TOOLS

Unit	Details	No. of Hours
I	Office Automation-Office and Office Automation	12
II	Computer Mail Systems - Telecommunication and Word Processor	12
III	WP Hardware Configuration	12
IV	Reprographics-Electronic Mail and Electronic-Filing	12
V	Facsimile Transmission and Micrographics Self study : Voice Technology	12
	Total	60
* Model preparation and Power Point Presentation – Related to the above topics are to be considered for Internal Exam only		

Text books :

- ❖ Office Automation Tools and Technology (Unit I & Unit-II)
- ❖ Office Automation Tools, Yatendra kumar & suitha varshney, Naveen prakashan pvt .Ltd

Reference Books:

- ❖ Office Automation Tools, Dr. Rizwan Ahmed , Naveen prakashan pvt. Ltd
- ❖ Office Automation Tools, Dr. Babasaheb Ambedkar

Web Resources:

- ❖ <http://mathforum.org>
- ❖ <http://ocw.mit.edu/ocwweb/Mathematics>,
- ❖ <http://www.opensource.org>
- ❖ www.mathpages.com

Mapping with Programme Outcomes: 3 Strong, 2 – Medium, 1 – Low

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	3	3	3	3
CO2	3	2	2	3	1	2	3	2	3
CO3	3	3	3	2	3	3	3	3	3
CO4	3	1	3	3	3	3	3	2	3
CO5	3	3	2	3	3	3	3	3	3
Weightage	15	12	13	14	13	14	15	13	15
Weighted percentage of course contribution to PO's	3	2.4	2.6	2.8	2.6	2.8	3	2.6	3

Course Coordinator**BOS Chairman**

SEC I: NUMERICAL ANALYSIS USING SCILAB

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S4PMAS05	SEC	Theory	Y	-	-	4	2

Learning Objectives

- ❖ This course define transcendental and polynomial equations and differentiate between them. Apply the concepts of eigenvalues and eigenvectors to real-world problems, including stability analysis and dimensionality reduction.

Course Outcomes		
Course Outcomes	On completion of this course, students will able to	Programme Outcomes
CO1	Explore the significance of solving transcendental equations in real-world applications	PO1, PO2
CO2	Apply theorems like the Intermediate Value Theorem and Rolle's Theorem to solve polynomial equations.	PO4,PO6
CO3	Implement numerical methods such as the Bisection Method, Newton-Raphson Method, and Secant Method to solve transcendental equations.	PO2, PO3
CO4	Learn various interpolation methods like linear interpolation, Lagrange interpolation, and Newton's divided differences.	PO3, PO5
CO5	Explore different methods of solving initial value problems (IVPs), including separation of variables, integrating factors, and numerical methods like Euler's Method.	PO2, PO3,PO6

SEC : NUMERICAL ANALYSIS USING SCILAB

Unit	Details	No. of Hours
I	Transcendental and Polynomial Equations	12
II	System of Linear Algebraic Equations and Eigenvalue Problems	12
III	Interpolation and Approximation	12
IV	Differentiation and Integration	12
V	Ordinary Differential Equations Initial Value Problems Self study :Initial Value Problems	12
	Total	60
* Model preparation and Power Point Presentation – Related to the above topics are to be considered for Internal Exam only		

Text book :

- ❖ Numerical Methods For Scientific And Engineering Computation by M. K. Jain, S. R. K. Iyengar And R. K. Jain.

Reference Books:

- ❖ Numerical Methods and principles analysis and algorithms ,S.Pal ,Oxford University Press.

Web Resources:

- ❖ <http://mathforum.org>
- ❖ <http://ocw.mit.edu/ocwweb/Mathematics>,
- ❖ <http://www.opensource.org>
- ❖ www.mathpages.com

Mapping with Programme Outcomes: 3 Strong, 2 – Medium, 1 – Low

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	3	3	3	3
CO2	3	2	2	3	1	2	3	2	3
CO3	3	3	3	2	3	3	3	3	3
CO4	3	1	3	3	3	3	3	2	3
CO5	3	3	2	3	3	3	3	3	3
Weightage	15	12	13	14	13	14	15	13	15
Weighted percentage of course contribution to PO's	3	2.4	2.6	2.8	2.6	2.8	3	2.6	3

Course Coordinator**BOS Chairman**

SEC : DIFFERENTIAL EQUATIONS USING SCILAB

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S4PMAS06	SEC	Theory	Y	-	-	4	2

Learning Objectives:

- ❖ The objective of this course is to equip students with a comprehensive understanding of the fundamental concepts and techniques in scilab and to apply in differential equations.

Course Outcomes		
Course Outcomes	On completion of this course, students will able to	Programme Outcomes
CO1	Define transcendental and polynomial equations and differentiate between them.	PO1, PO2
CO2	Learn to perform basic operations in Scilab, including arithmetic and matrix manipulations.	PO5
CO3	Develop basic programming skills to write and execute Scilab scripts.	PO2, PO4
CO4	To illustrate the algorithms used in solving ordinary differential equations.	PO3, PO5
CO5	Demonstrate the programming used in extended polynomials	PO5, PO6

SEC : DIFFERENTIAL EQUATIONS USING SCILAB

Unit	Details	No. of Hours
I	An Introduction to Scilab – Matrices	12
II	Scilab Programming	12
III	Functions –Plotting	12
IV	Solving Ordinary Differential Equations	12
V	Polynomials in Scilab Self study : Extended Professional	12
	Total	60
* Model preparation and Power Point Presentation – Related to the above topics are to be considered for Internal Exam only		

Text book :

- ❖ Programming Using Scilab, Akhilesh Kumar

Reference Books:

- ❖ Ordinary Differential Equations with Scilab by Gilberto E.Urroz.

Web Resources:

- ❖ <http://mathforum.org>
- ❖ <http://ocw.mit.edu/ocwwweb/Mathematics>,
- ❖ <http://www.opensource.org>
- ❖ www.mathpages.com

Mapping with Programme Outcomes: 3 Strong, 2 – Medium, 1 – Low

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	1	3	3	3	3	3	3	2	3
CO2	3	2	2	3	1	2	3	2	3
CO3	3	3	3	2	3	3	3	3	3
CO4	3	1	3	3	3	3	3	2	3
CO5	3	3	2	3	3	3	3	3	3
Weightage	13	12	13	14	13	14	15	12	15
Weighted percentage of course contribution to PO's	2.6	2.4	2.6	2.8	2.6	2.8	3	2.4	3

Course Coordinator**BOS Chairman**

**SEC : INDUSTRIAL MATHEMATICS USING LATEST
PROGRAMMING PACKAGES**

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S4PMAS07	SEC	Theory	Y	-	-	4	2

Learning Objectives

- ❖ This aims to introduce to students the pseudosteady- state approximate solution.
- ❖ To learn to solve the continuous casting case study including laser drilling

Course Outcomes		
Course Outcomes	On completion of this course, students will able to	Programme Outcomes
CO1	Introduce the case studies on diffusion equations and heat conduction equations.	PO1, PO2,PO3
CO2	Define the Boundary conditions , techniques to solve the Scaling equations –and Dimensional analysis	PO1,PO3
CO3	To demonstrate the Continuous Casting and Boltzmann similarity solution.	PO2, PO4
CO4	Explain the Stretching transformations including the diffusion from a point source	PO3, PO5
CO5	Apply the method of Laser Drilling and Method of perturbations in solving the laser drilling case study .	PO2, PO6

**SEC : INDUSTRIAL MATHEMATICS/STATISTICS USING LATEST
PROGRAMMING PACKAGES**

Unit	Details	No. of Hours
I	Mathematics in industry- Overview of the case studies- Units and dimensions - Diffusion equations - Heat conduction equations	12
II	Boundary conditions -Solving the heat/diffusion equation – Scaling equations - Dimensional analysis	12
III	Continuous Casting - Introduction to the case study problem – The Boltzmann similarity solution- A moving boundary problem - The pseudosteady- state approximate solution- Solving the continuous casting case study	12
IV	Water Filtration - Introduction to the case study problem – Stretching transformations - Diffusion from a point source - Solving the water filtration case study	12
V	Laser Drilling -Introduction to the case study problem - Method of perturbations -Boundary perturbations Self study : Solving the laser drilling case study	12
	Total	60
* Model preparation and Power Point Presentation – Related to the above topics are to be considered for Internal Exam only		

Text book :

- ❖ Industrial Mathematics Case Studies in the Diffusion of Heat and Matter, Glenn R. Fulford Philip Broadbridge

Reference Books:

- ❖ Conduction of Heat in solids, Carslaw, H.S and Jaeger, J.C , Clarendon Press 1959(2nd Edition)

Web Resources:

- ❖ <http://mathforum.org>
- ❖ <http://ocw.mit.edu/ocwwweb/Mathematics>,
- ❖ <http://www.opensource.org>
- ❖ www.mathpages.com

Mapping with Programme Outcomes: 3 Strong, 2 – Medium, 1 – Low

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	3	3	2	3
CO2	3	3	2	3	1	2	3	2	3
CO3	3	3	3	2	3	2	3	3	3
CO4	2	1	3	3	3	3	3	2	3
CO5	3	3	2	3	3	3	3	3	3
Weightage	14	13	13	14	13	13	15	12	15
Weighted percentage of course contribution to PO's	2.8	2.6	2.6	2.8	2.6	2.6	3	2.4	3

Course Coordinator**BOS Chairman**

EXTRA DISCIPLINARY COURSES FOR OTHER DEPARTMENTS**(NOT FOR MATHEMATICS STUDENTS)****EDC I – MATHEMATICS FOR LIFE SCIENCES**

Subject Code	Subject	Category	L	T	P	Hours	Credit
24PMAED01	EDC –I	Theory	Y	Y	-	3	2

Learning Objectives :

- ❖ The focus of the course is on scientific study of normal functions in living systems. The emphasis is on exposure to nonlinear differential equations with examples such as heartbeat, chemical reactions and nerve impulse transmission.
- ❖ The basic concepts of the probability to understand molecular evolution and genetics have also been applied.

Course Learning Outcome (for Mapping with POs and PSOs)

Course Outcomes	On Completion of this course, students will:	Program Outcomes
CO1	Analysis and interpretation of bio mathematical models such as population growth, cell division, and predator-prey models.	PO1,PO3
CO2	apply the basic concepts of probability to molecular evolution and genetics	PO1,PO3,PO4
CO3	Identify and appreciate the unifying influence of mathematical modelling in different Disciplines	PO2,PO3
CO4	Explain Allosteric enzymes	PO1,PO6
CO5	Analyze and translate a real-world problem into a mathematical problem	PO3,PO4

EDC I – MATHEMATICS FOR LIFE SCIENCES

Unit	Details	No. of Hours
I	Cell Growth-Exponential growth and Decay – Determination of growth or decay rates- The method of least squares – Nutrient Uptake by a cell –Inhomogeneous Differential equations.	6
II	Growth of a Microbial colony – Growth in a Chemo stat – Interacting Populations – Mutation and Reversion in Bacterial growth.	6
III	Enzyme Kinematics: The Michaelis – Menton Theory – Enzyme Substrate – Inhibitor system – Cooperative dimmer – Allosteric enzymes –Other alloseteric theories.	6
IV	The Cooperative dimmer – Allosteric enzymes – Other alloseteric theories.	6
V	Hemoglobin – Graph theory and Steady state Enzyme Kinetics – Enzyme – Substrate – Modifier system – Enzyme Substrate - *Self Study: Activator system.	6
	Total	30
*Model preparation and Power Point Presentation – Related to the above topics are to be considered for Internal Exam only		

Text Books :

❖ S. I. Rubinow, Introduction Mathematical Biology, Dover publications, New York, 1975. Chapter I and Chapter 2 (Sections 2.1,2.3, to 2.11.)

Website and e-Learning Source :

- ❖ <http://mathforum.org>
- ❖ <http://ocw.mit.edu/ocwweb/Mathematics>
- ❖ <http://www.opensource.org>
- ❖ www.mathpages.com

Mapping with Programme Outcomes: 3 Strong, 2- Medium, 1- Low

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	2	2	2	2	2	2	2	1	2
CO2	2	1	2	3	2	1	3	2	1
CO3	2	2	2	1	2	1	2	1	2
CO4	2	2	2	2	2	3	2	1	1
CO5	2	1	2	2	2	2	3	2	1
Weightage	10	8	10	10	10	9	12	7	7
Weighted percentage of Course Contribution to POs	2	1.6	2	2	2	1.8	2.4	1.4	1.4

Course Coordinator

BOS Chairman

EDC II – MATHEMATICS FOR SOCIAL SCIENCES

Subject Code	Subject	Category	L	T	P	Hours	Credit
24PMAED02	ED -II	Theory	Y	Y	-	3	2

Learning Objectives :

- ❖ To gain basic concepts of set theory, functions and matrices

Course Learning Outcome (for Mapping with POs and PSOs)

Course Outcomes	On Completion of this course, students will:	Program Outcomes
CO1	Understand and apply propositional logic, quantifiers, and set theory	PO1,PO3,PO5
CO2	Solve linear and quadratic equations and analyze functions	PO4,PO6
CO3	Explore various types of functions	PO2,PO3,PO5
CO4	Learn the basic properties of logarithmic, exponential and trigonometric functions	PO1,PO3
CO5	Perform matrix algebra and concept of matrix echelon forms	PO1,PO4,PO5

EDC II – MATHEMATICS FOR SOCIAL SCIENCES

Unit	Details	No. of Hours
I	Propositional Logic and set Theory Propositional Logic Propositional Logic -Open propositions and quantifiers -Arguments and Validity - Set Theory.	6
II	Functions The real number system - Solving equations and inequalities; linear and quadratic equations -Review of relations and functions	6
III	Real valued functions and their properties -Types of functions and inverse of a function - Polynomials, zeros of polynomials, Rational functions and their graphs	6
IV	Definition and basic properties of logarithmic, exponential, trigonometric functions and their graph	6
V	Matrices and determinant Definition of a matrix -Matrix Algebra -Types of matrices - Elementary row operations *Self Study: Row echelon form and reduced row echelon form of a matrix.	6
	Total	30
*Model preparation and Power Point Presentation – Related to the above topics are to be considered for Internal Exam only		

Text Books :

- ❖ Mathematics for Social Sciences , Dr. Berhanu Bekele, Ato MulugetaNaizghi.

Website and e-Learning Source :

- ❖ <http://mathforum.org>
- ❖ <http://ocw.mit.edu/ocwweb/Mathematics>
- ❖ <http://www.opensource.org>
- ❖ www.mathpages.com

Mapping with Programme Outcomes: 3 Strong, 2- Medium, 1- Low

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	2	2	2	2	2	2	2	1	2
CO2	1	1	2	3	2	3	3	2	1
CO3	1	2	2	1	2	1	2	1	2
CO4	3	2	2	2	2	2	2	1	1
CO5	2	1	2	2	2	2	3	2	1
Weightage	9	8	10	10	10	10	12	7	7
Weighted percentage of Course Contribution to POs	1.8	1.6	2	2	2	2	2.4	1.4	1.4

Course Coordinator

BOS Chairman

EDC III – STATISTICS FOR LIFE AND SOCIAL SCIENCES

Subject Code	Subject	Category	L	T	P	Hours	Credit
24PMAED03	EDC -III	Theory	Y	Y	-	3	2

Learning Objectives :

- ❖ Equip students with fundamental statistical concepts and techniques to analyze and interpret data in life and social sciences

Course Learning Outcome (for Mapping with POs and PSOs)

Course Outcomes	On Completion of this course, students will:	Program Outcomes
CO1	Understand the fundamental statistics, including data collection and set theory	PO1,PO3,PO5
CO2	Present and summarize data using various diagrams, frequency distributions, and measures of central tendency	PO3,PO4
CO3	Apply probability theory including permutation, combination and binomial distribution in real world scenarios	PO1,PO3,PO5
CO4	Grasp the significance of statistical inquiries and basic research methodologies	PO2,PO4
CO5	Explore the nature of science and foundational concepts in social statistics.	PO1,PO5

EDC III – STATISTICS FOR LIFE AND SOCIAL SCIENCES

Unit	Details	No. of Hours
I	Definitions, and Scope of Statistics -Approach to Data Collection - Introduction to Set Theory I & II -Concepts of Logic	6
II	Diagrammatic Presentation of Data -Frequency Distribution - Graphical Presentation of Data - Measures of Central Tendency	6
III	Probability Theory I&II - Permutation Theorem -Combination -Binominal Distribution	6
IV	Nature and Importance of Statistical Inquiries - Basic Research Methodology I & II	6
V	Nature of Science *Self Study :Some Basic Concepts in Social Statistics.	6
	Total	30
*Model preparation and Power Point Presentation – Related to the above topics are to be considered for Internal Exam only		

Text Books :

❖ Basic Statistics For Social Sciences ,Dr. Henry Obasogie (Course Reviewer) – Benson Idahosa University Dr. Moses Etila Shaibu (CourseEditor) – NOUN.

Reference Books:

- ❖ Osuala, E.C. (1982). Introduction to Research Methodology. Awka Rd Onitsha, Nigeria: Africana-Fep Publisher Limited.
- ❖ Okoro, E. (2002). Quantitative Techniques in Urban Analysis. Ibadan: Kraft Books Ltd. Kerlinger, Fred N. (1964). .
- ❖ Foundations of Behavioural Research. New York: Holt, Rinehart and Winton. Whitney, F.L. (1968).
- ❖ The Elements of Research. New York: Prentice- Hall.

Website and e-Learning Source :

- ❖ <http://mathforum.org>
- ❖ <http://ocw.mit.edu/ocwweb/Mathematics>
- ❖ <http://www.opensource.org>
- ❖ www.mathpages.com

Mapping with Programme Outcomes: 3 Strong, 2- Medium, 1- Low

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	2	2	2	2	2	2	1	1	2
CO2	2	1	2	3	2	1	2	2	3
CO3	2	2	2	1	2	1	1	1	2
CO4	2	2	2	2	2	3	1	1	2
CO5	2	1	2	2	2	2	2	2	3
Weightage	10	8	10	10	10	9	7	7	12
Weighted percentage of Course Contribution to POs	2	1.6	2	2	2	1.8	1.4	1.4	2.4

Course Coordinator

BOS Chairman

EDC IV – GAME THEORY and STRATEGY

Subject Code	Subject	Category	L	T	P	Hours	Credit
24PMAED04	EDC -IV	Theory	2	1	-	3	2

Learning Objectives :

- ❖ It focuses on fundamentals of game theory including basic concepts and techniques
- ❖ It will help students sharpen their understanding of strategic behavior in different situations involving many individuals.
- ❖ The students will learn how to recognize and model strategic situations

Course Learning Outcome (for Mapping with POs and PSOs)

Course Outcomes	On Completion of this course, students will:	Program Outcomes
CO1	Distinguish a game situation from a pure individuals' decision problem	PO1,PO3,PO5
CO2	Explain graphical representation of mixed strategies	PO1,PO3,PO4
CO3	Explain concepts of dominant, dominated and rationalizable strategies, pure and mixed strategies, and best responses	PO1,PO4,PO6
CO4	Analyze economic situations using game theoretic techniques	PO3,PO5,PO6
CO5	Solve simple games using mapping method.	PO1,PO4,PO5

ED IV – GAME THEORY and STRATEGY

Unit	Details	No. of Hours
I	Game, Strategy and Saddle Point: Introduction- Description of a game of strategy- Relations among expectations- Saddle points- Game with perfect information's. Chapter 1.	6
II	The Fundamentals: Game without saddle points-mixed strategies- Graphical representation of mixed strategies – the minimax theorem – optimal mixed strategy – graphical representation of minimax theorem and proof of minimax theorem. Chapter 2.	6
III	Properties of Optimal Strategies: Many optimal strategies – some properties of an optimal strategies – convex set of optimal strategies- operation on games – dominated strategies – all strategies active. Chapter 3(sec: 3.1-3.6)	6
IV	Method of Solving games: Solving for optimal strategies – Guess and verify – Examination of submatrices – Successive approximations - Graphical solutions of 3 x 3 games. Chapter 5.(sec 5.1-5.5)	6
V	Mapping method for solving games with constraints – Mapping method for solving games *Self study: solution of reconnaissance game by mapping method. Chapter 5 (sec 5.6-5.8).	6
	Total	30
*Model preparation and Power Point Presentation – Related to the above topics are to be considered for Internal Exam only		

Text Books :

- ❖ Melvin Dresher, Game of Strategy Theory and Application, Prentice-Hall-Inc, USA, 1961

Reference Books:

- ❖ Kanti Swarup, P.K.Gupta and Man Mohan, –Operations Research, Eighth Editionl, Sultan Chand & Sons, New Delhi, 1999.
- ❖ S.Hillier and J.Liebermann, Operations Research, Sixth Edition, Mc Graw Hill Company, 1995.
- ❖ J. K. Sharma, Operations Research problems and solution, Third edition, Mackmillan Publishers India Ltd, India, 2012.
- ❖ Guillermo Owen, Game Theory, 2nd edition, Academic Press, 1982.
- ❖ Philip D. Straffin, Game Theory and Strategy, The Mathematical Association of America, USA, 1993

Website and e-Learning Source :

- ❖ <https://nptel.ac.in/courses/110101133>
- ❖ <https://archive.nptel.ac.in/courses/110/104/110104063/>

Mapping with Programme Outcomes: 3 Strong, 2- Medium, 1- Low

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	2	2	2	2	2	2	2	1	2
CO2	1	1	2	3	2	3	3	2	1
CO3	1	2	2	1	2	1	2	1	2
CO4	3	2	2	2	2	2	2	1	1
CO5	2	1	2	2	2	2	3	2	1
Weightage	9	8	10	10	10	10	12	7	7
Weighted percentage of Course Contribution to POs	1.8	1.6	2	2	2	2	2.4	1.4	1.4

Course Coordinator

BOS Chairman

EDC V – HISTORY OF MATHEMATICS

Subject Code	Subject	Category	L	T	P	Hours	Credit
24PMAED05	EDC -V	Theory	Y	-	-	2	1

Learning Objectives :

- ❖ Provide comprehensive understanding of the development of mathematical concepts from ancient civilizations to the twilight of Greek mathematics

Course Learning Outcome (for Mapping with POs and PSOs)

Course Outcomes	On Completion of this course, students will:	Program Outcomes
CO1	Explore and understand the origin and development of early number systems and mathematical symbols	PO1,PO2
CO2	Analyze the role and contributions of mathematics in early civilizations such as Mesopotamia and Egypt	PO4,PO6
CO3	Trace the foundations of Greek mathematics and its influence on mathematical thought	PO3,PO5
CO4	Understand Euclid's contributions to geometry and the significance of the Alexandrian School	PO1,PO4
CO5	Study the contributions of Diophantus and the decline of Greek mathematical dominance	PO2,PO3,PO5

EDC V – HISTORY OF MATHEMATICS

Unit	Details	No. of Hours
I	Early Number Systems and Symbols	6
II	Mathematics in Early Civilizations	6
III	The Beginnings of Greek Mathematics	6
IV	The Alexandrian School: Euclid	6
V	The Twilight of Greek Mathematics: Diophantus	6
	Total	30
*Model preparation and Power Point Presentation – Related to the above topics are to be considered for Internal Exam only		

Text Books :

- ❖ The History of Mathematics , Seventh Edition David M. Burton University of New Hampshire

Reference Books:

- ❖ Aczel, Amer. The Artist and the Mathematician: The Story of Nicolas Bourbaki, the Genius Mathematician Who Never Existed. New York:Thunder's Mouth Press, 2006.
- ❖ Appel, Kenneth, and Haken, Wolfgang. —Every Planar Map Is Four Colorable Journal of Recreational Mathematics 9 (1976–1977): 161–169.

Website and e-Learning Source:

- ❖ <http://mathforum.org>
- ❖ <http://ocw.mit.edu/ocwwweb/Mathematics>
- ❖ www.mathpages.com

Mapping with Programme Outcomes: 3 Strong, 2- Medium, 1- Low

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	2	2	1	2
CO2	1	1	2	3	2	3	3	2	1
CO3	1	2	2	1	2	1	2	1	2
CO4	3	2	2	2	2	2	2	1	1
CO5	2	1	2	2	2	2	3	2	1
Weightage	10	9	10	10	10	10	12	7	7
Weighted percentage of Course Contribution to POs	2	1.8	2	2	2	2	2.4	1.4	1.4

Course Coordinator

BOS Chairman

NON MAJOR ELECTIVE
NME II :OPTIMIZATION TECHNIQUES

Subject Code	Subject	Category	L	T	P	Hours	Credit
24S3PSTN02	NME - II	Theory	Y	-	-	3	2

Learning Objectives

- ❖ Understand the problem formulation by using linear, dynamic programming, game theory and queuing models
- ❖ Acquire knowledge on stochastic models for discrete and continuous variables to control inventory and simulation of manufacturing models for the production decision making
- ❖ Formulation of mathematical models for quantitative analysis of managerial problems in industry

Course Outcomes		
Course Outcomes	On completion of this course, students will be able to	Programme Outcomes
CO1	Recall the theoretical foundations of various issues related to linear programming modeling to formulate real-world problems as a L P Model Effectively interpret the results from the control charts	PO1,PO2,P03
CO2	Identify appropriate optimization method to solve complex problems involved in various industries.	PO1,PO3
CO3	Find the appropriate algorithm for allocation of resources to optimize the process of sequencing problem	PO2,PO4
CO4	Explain the theoretical workings of sequencing techniques for effective scheduling of jobs on machines.	PO3,PO5
CO5	Integrate optimization methods with computational tools to interpret solutions and make informed decisions in applied fields like engineering, management, and data science.	PO2,PO6

NMEII :OPTIMIZATION TECHNIQUES

Unit	Details	No. ofHours
I	Development, definition, characteristics and phases, types of operation research models, applications; Allocation: linear programming, problem formulation, graphical solution, simplex method, artificial variables techniques, two-phase method, big-M method.	09
II	Transportation problem: Formulation, optimal solution, unbalanced transportation problem, Degeneracy; Assignment problem, formulation, optimal solution, variants of assignment problem, traveling salesman problem	09
III	Sequencing: Introduction, flow, shop sequencing, n jobs through two machines, n jobs through three machines, job shop sequencing, and two jobs through “m” machines.	09
IV	Theory of Games: Introduction – Terminology, Solution of games with saddle points and without saddle points, 2×2 games, dominance principle, m X 2 & 2 X n games, Graphical method.	09
V	Waiting Lines: Introduction, Terminology, Single Channel, Poisson arrivals and exponential service times with infinite population and finite population models, Multichannel, Self Study: Poisson arrivals and exponential service times with infinite population.	09
	Total	45
* Model preparation and Power Point Presentation – Related to the above topics are to be considered for Internal Exam only		

Text books :

- ❖ J. K. Sharma, “Operations Research”, Macmillan, 5th Edition, 2012.
- ❖ R. Pannerselvan, “Operations Research”, 2nd Edition, PHI Publications, 2006..

Reference Books:

- ❖ M. Natarajan, P. Balasubramani, A. Tamilarasi, “Operations Research”, Pearson Education, 2013.
- ❖ Maurice Saseini, ArhurYaspan, Lawrence Friedman, “Operations Research: Methods & Problems”, 1 st Edition, 1959.

WebResources:

- ❖ https://www.aicteindia.org/flipbook/p&ap/Vol.%20II%20UG/UG_2.html#p=
- ❖ <https://www.britannica.com/topic/operations-research>

MappingwithProgrammeOutcomes: 3Strong,2–Medium,1–Low

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	3	3	3	3
CO2	3	3	2	3	1	2	3	3	3
CO3	3	3	3	2	3	2	3	3	3
CO4	2	1	3	3	3	3	3	3	3
CO5	3	3	2	3	3	3	3	3	3
Weightage	14	13	13	14	13	13	15	15	15
Weighted percentage of course contribution to PO's	2.8	2.6	2.6	2.8	2.6	2.6	3	3	3

Course Coordinator

BOS Chairman

