MOTHER TERESA WOMEN'S UNIVERSITY
KODAIKANAL

DEPARTMENT OF MATHEMATICS

M.Sc. MATHEMATICS PROGRAMME

SYLLABI
WITH EFFECT FROM THE ACADEMIC YEAR
2018 – 2019 Onwards
(CHOICE BASED CREDIT SYSTEM)

PROGRAM EDUCATIONAL OBJECTIVES

The M. Sc Mathematics curriculum is dedicated to preparing students for productive careers after 3-5 years of graduation.

1. **Apply their knowledge in modern industry or teaching, or secure acceptance in highquality graduate programs in mathematics.**
2. **Development in their chosen profession and/or progress toward an advanced degree**
3. **The trust and respect of others as effective and ethical team members.**
4. **Graduates will become effective collaborators and innovators, leading or participating in efforts to address social, technical and business challenges.**
5. **Promote the culture of interdisciplinary research among all disciplines and applied mathematics.**

PROGRAMME OUTCOMES

PO1: Inculcate critical thinking to carry out scientific investigation objectively without being biased with preconceived notions.

PO2: Equip the student with skills to analyze problems, formulate an hypothesis, evaluate and validate results, and draw reasonable conclusions thereof.

PO3: Prepare students for pursuing research or careers in industry in mathematical sciences and allied fields

PO4: Continue to acquire relevant knowledge and skills appropriate to professional activities and demonstrate highest standards of ethical issues in mathematical sciences.

PO5: Create awareness to become an enlightened citizen with commitment to deliver one's responsibilities within the scope of bestowed rights and privileges.

PROGRAMME SPECIFIC OUTCOMES

PSO1: Understanding of the fundamental axioms in mathematics and capability of developing ideas based on them.

PSO2: Prepare and motivate students for research studies in mathematics and related elds.

PSO3: Provide advanced knowledge on topics in pure mathematics, empowering the students to pursue higher degrees at reputed academic institutions.

PSO4: Nurture problem solving skills, thinking, creativity through assignments, project work.

PSO5: Assist students in preparing (personal guidance, books) for competitive exams e.g. NET, GATE, etc.

ALLOCATION OF PAPERS AND CREDITS (SEMESTER- WISE) FOR PG PROGRAMMES AS PER THE TANSCHE RULES
MATHEMATICS
PG Course Structure under Choice Based Credit System (CBCS)

S.No.	Subject Code	Subject Title	Hours	Credits	Int.	Ext	Total
First Semester							
1	PMTT11	Linear Algebra	6	5	25	75	100
2	PMTT12	Real Analysis I	6	5	25	75	100
3	PMTT13	Differential Equations	6	5	25	75	100
4	PMTT14	Graph Theory	6	5	25	75	100
5	PMTE11	Major Elective	6	5	25	75	100
Total			**30**	**25**			**500**
Second Semester							
1	PMTT21	Algebra	6	5	25	75	100
2	PMTT22	Real Analysis II	6	5	25	75	100
3	PMTT23	Topology	6	5	25	75	100
4	PMTT24	Optimization Techniques	6	5	25	75	100
5	PMTE22	Major Elective	6	5	25	75	100
	Total		**30**	**25**			**500**
Third Semester							
1	PMTT31	Complex Analysis	6	5	25	75	100
2	PMTT32	Measure Theory	6	5	25	75	100
3	PMTT33	Classical Dynamics	6	5	25	75	100
4	PMTT34	Calculus of variations and Integral Equations	6	5	25	75	100
5	PMTE33	Major Elective	6	5	25	75	100
	Total		**30**	**25**			**500**
Fourth Semester							
1	PMTT41	Functional Analysis	6	5	25	75	100
2	PMTT42	Differential Geometry	6	5	25	75	100
3	PMTP43	Project	18	5	25	75	100
	TOTAL		**30**	**15**			**300**
Grand Total				**90**			**1800**

List of Elective Courses

S.No	Major Elective Courses
1.	Algebraic Number Theory
2.	Automata Theory
3.	Probability Theory and Statistics
4.	MatLab and LaTeX
5.	Fuzzy sets and their Applications
6.	Neural Network
7.	Stochastic Processes
8.	Fluid Dynamics
9.	Non linear Differential Equations
10.	Financial Mathematics
11.	Control Theory
12.	Fractal Analysis
13.	Tensor Analysis and special theory of relativity
14.	Mathematical Biology

Reference/Text Books contain the following details:

I. Name of the Author
II. Title of the Book
III. Name of the Publisher
IV. Year

SCHEME OF EXAMINATION

Internal (Theory) - 25

Test	- 15
Attendance	- 5
Assignment/Technical Quiz	- 5
Total	- 25

External (Theory) - 75

QUESTION PATTERN

1.	10*1 Marks (Objective type / Multiple choice 2 Question from each unit)	10
2.	5*4 Marks (from each unit either or choice)	20
3.	3*15 Marks (Open choice Any Three Questions out of 5, one question from each unit)	45
	Total	75

The Internal Assessment for Practical : 25

The External Assessment for Practical : 75

Semester I

Course Code	Course Name	Category	L	T	P	Credit
PMTT11	**LINEAR ALGEBRA**	**Core**	**86**	**4**	**-**	**5**

Objectives:

- To provide sound foundation in linear Algebra , as well as understanding of the principles underlying in linear Algebra and deep knowledge about various algebraic structures
- To prepare students to understand principles, concepts necessary to formulate and *give* a depth knowledge about elementary matrix operations.
- To prepare the students for further courses in higher mathematics and related disciplines and solve linear equation

Course Outcomes:

Upon successful completion of this course students will be able to:

CO1: Determine relationship between coefficient matrix invertibility and solutions to a system of linear equations and the inverse matrices.

CO2: Find a basis for the row space, column space and null space of a matrix and find the rank and nullity of a matrix.

CO3: Students completing this course will be able to find the matrix representation of a linear transformation given bases of the relevant vector spaces.

CO4: Use computational techniques and algebraic skills essential for the study of systems of linear equations, matrix algebra, vector spaces, eigenvalues and eigenvectors, orthogonality and diagonalization. (Computational and Algebraic Skills).

CO5: Work collaboratively with peers and instructors to acquire mathematical understanding and to formulate and solve problems and present solutions.

CO Number	CO Statement	Knowledge Level
CO1	**Demonstrate competence with the basic ideas of linear Algebra including the concepts of vector spaces, inner product spaces, modules and linear transformations**	**K2**
CO2	**Become familiar with the theorems and the characteristics of linear spaces and linear transformations**	**K3**
CO3	**Apply properties and theorems about linear spaces to specific mathematical structures that satisfy the linear space**	

	axioms	**K4**
CO4	**Compose clear and accurate proofs using the concepts of linear Algebra**	**K5**
CO5	**Appreciate the significance of vector spaces and linear transformations**	**K6**

Mapping with Programme Outcomes

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	**S**	**S**	**S**	**S**	**S**
CO2	**S**	**S**	**S**	**M**	**S**
CO3	**S**	**S**	**S**	**S**	**S**
CO4	**S**	**S**	**M**	**S**	**S**
CO5	**S**	**S**	**S**	**S**	**M**

S- Strong; M-Medium; L-Low

PMTT11 LINEAR ALGEBRA 6 Hours/5 Credits

Unit I: Vector Spaces: Introduction – Vector spaces – Subspaces – Linear combinations and systems of linear equations – Linear dependence and linear independence – Bases and dimensions – Maximal linearly independent subsets.

Unit II: Linear Transformations and Matrices: Linear transformations, Null spaces, and Ranges – The matrix representation of a linear transformations – Composition of linear transformations and matrix multiplication – Invertibility and Isomorphisms – The change of coordinate matrix – Dual spaces – Homogeneous linear differential equations with constant coefficients.

Unit III: Elementary Matrix Operations and Systems of Linear Equations: Elementary matrix operations and Elementary matrices – The rank of matrix and matrix inverse – Systems of linear equations theoretical aspects – Systems of linear equations – computational aspects.

Unit IV: Determinants: Determinants of order 2- Determinants of order n – Properties of determinants - Summary – Important facts about determinants – A characterization of the determinant.

Unit V: Diagonalization: Eigen values and Eigen vectors – Diagonalizability – Matrix limits and Markov chains – Invariant subspaces and the Cayley Hamilton theorem.

Text Book

1Stephen H.Friedberg, Arnold J. Insel, Lawrence E. Spence, **Linear Algebra**, Pearson New International Edition, fourth edition , 2014

Chapter 1 : (Sec1.1- Sec1.7).
Chapter 2 : (Sec 2.1-Sec 2.7).
Chapter 3 : (Sec3.1 - Sec3.4).
Chapter 4 : (Sec4.1- Sec4.5).
Chapter 5 : (Sec 5.1- Sec 5.4).

Reference books:

1. John. B. Fraleigh, A First Course in Abstract Algebra, 7th Edition, Addison-Wesley,New Delhi, 2003.
2. S. Kumerason, “Linear Algebra” Prentoice Hall of India Pvt Ltd New Delhi, 2000.
3. D.S.Malik, J.N.Mordeson and M.K.Sen, Fundamental of Abstract Algebra, McGraw Hill(International Edition),New York. 1997.
4. Kenneth Hoffman and Ray Kunze, Linear Algebra, 2nd edition, Prentice Hall, Inc., New Jersey, 2010.

Pedagogy

Chalk and talk, Group Discussion, PPT, Seminar, Quiz, As and video lecture

*****

Semester I

Course Code	Course Name	Category	L	T	P	Credit
PMTT12	REAL ANALYSIS- I	Core	86	4	-	5

Objectives:

- **To convey concepts of real valued functions in detail.**
- **To provide the deep knowledge about sequences and series.**
- **To make a clear difference between differentiability and continuity.**
- **To know some basic theorems.**

Note: The Question paper may contain problems to a maximum of 20%

Course Outcomes: Upon the successful completion of the course, students will be able to

CO1: Students will be able to demonstrate competence with elementary properties of sets by proving identities involving union and intersection and Cartesian Products of sets.

CO2: Students will be able to demonstrate competence with elementary properties of functions by proving results involving composite functions and inverse functions.

CO3: Students will be able to demonstrate competence with the algebraic and order properties of real numbers.

CO4: Students will be able to demonstrate competence with properties of real numbers by finding supremum and infimum of sets and using the completeness property of real numbers.

CO5: Students will be able to demonstrate ability to use Taylor Theorem, the Mean value Theorem, and use L'Hôpital's Rule to compute limits of functions.

CO Number	CO Statement	Knowledge Level
CO1	Describe fundamental properties of the real numbers that lead to the formal development of real analysis	K2
CO2	The extended real number system in the complex field and Euclidean spaces developing the theory underpinning real analysis	K3
CO3	Demonstrate an understanding of limits and how they are used in sequences, series, differentiation and integration	K4
CO4	Construct various mathematical proofs of basic results in Continuity and connectedness	K5
CO5	Appreciate how abstract ideas and various methods in The derivative of a real function can be applied to important practical problems. Exhibits rigorous mathematical proofs in derivatives of Higher order	K6

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	M	S
CO2	S	S	S	S	S
CO3	S	S	M	S	M
CO4	S	M	S	S	M
CO5	S	S	M	S	S

S- Strong; M-Medium; L-Low

PMTT12 REAL ANALYSIS- I 6 Hours/5 Credits

Unit I: The Real and Complex Number Systems: Introduction, Ordered sets – Fields - The real field - The extended real number system - The complex field - Euclidean spaces.

Unit II: Basic Topology: Finite - Countable and Uncountable sets - Metric spaces - Compact sets - Perfect sets - Connected sets.

Unit III: Numerical Sequences and Series: Convergent sequences –Subsequences - Cauchy sequences - Upper and lower limits - Some special sequences – Series - The number e - The root and ratio tests - Fourier series - Summation by parts - Absolute convergence - Addition and multiplication of series - Rearrangements.

Unit IV: Continuity: Limits of functions - Continuous functions - Continuity and compactness - Continuity and connectedness - Monotonic functions - Infinite limits and limits at infinity.

Unit V: Differentiation: The derivative of a real function - Mean value theorems - The continuity of derivatives - L'Hospital' rule - Derivatives of Higher order - Taylor's theorem - Differentiation of vector valued functions.

Text Book:

Walter Rudin, **Principles of Mathematical Analysis**, 3rd Edition, McGraw – Hill International Book Company, Singapore, (1982). Units 1-5: Chapters: 1 – 5 (Including Appendix of chapter 1).

Reference Books:

1. Tom Apostol, Mathematical Analysis, Addison Wesley Publishing Company, London-1971.
2. R. G. Bartle & D.R. Sherbert, Introduction to Real Analysis, John Wiley & Sons, New York, 1982.
3. Kenneth A. Ross, Elementary Analysis: The theory of Calculus, Springer, New York, 2004.
4. K. R. Stromberg, An Introduction to Classical Real Analysis, Wadsworth, 1981.
5. G.F.Simmons, Introduction to Topology and Modern Analysis, McGraw – Hill, New Delhi, 2004.

*****

pedagogy :

Chalk & talk, PPT, Group discussion, Seminar, Quiz, assignment and video Lecture

Semester I

Course Code	Course Name	Category	L	T	P	Credit
PMTT13	DIFFERENTIAL EQUATIONS	Core	86	4	-	5

Objectives:

- **Differential equations arise for many problems in oscillations of mechanical and electrical systems**
- **It plays a very important role in all modern scientific and engineering studies.**
- **To give an in-depth knowledge of differential equations and their applications.**
- **Solve the higher order differential equations in different types with initial and boundary conditions**
- **Use the method of separation of variables to reduce some partial differential equations to ordinary differential equations of 2^{nd} order.**
- **To make the students to solve the practical problems used differential equations.**

Course Outcomes: Upon the successful completion of the course, students will be able to

CO1: Recognize differential equations that can be solved by each of the three methods – direct integration, separation of variables and integrating factor method – and use the appropriate method to solve them

CO2: Use an initial condition to find a particular solution of a differential equation, given a general solution

CO3: Check a solution of a differential equation in explicit or implicit form, by substituting it into the differential equation

CO4: Understand the terms 'exponential growth/decay', 'proportionate growth rate' and 'doubling/halving time' when applied to population models, and the terms 'exponential decay', 'decay constant' and 'half-life' when applied to radioactivity

CO Number	CO Statement	Knowledge Level
CO1	Solve a variety of first order differential equations selecting from a variety of techniques	K2
CO2	Solve a variety of second order differential equations, selecting from several techniques	K2
CO3	Give series solutions (and approximations) for second order linear differential equations, both at ordinary points and at regular singular point	K3
CO4	Investigate boundary values problems and point out its significance	K5

Mapping with Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	S	S
CO2	S	M	S	S	S
CO3	S	S	M	S	S
CO4	S	S	S	M	S

PMTT13 DIFFERENTIAL EQUATIONS 6 Hours /5 Credits

Unit I: The general solution of the homogeneous equation– he use of one known solution to find another – The method of variation of parameters – Power Series solutions. A review of power series– Series solutions of first order equations – Second order linear equations; Ordinary points.

Unit II: Regular Singular Points – Gauss's hypergeometric equation – The Point at infinity - Legendre Polynomials – Bessel functions – Properties of Legendre Polynomials and Bessel functions.

Unit III: Linear Systems of First Order Equations – Homogeneous Equations with Constant Coefficients – The Existence and Uniqueness of Solutions of Initial Value Problem for First Order Ordinary Differential Equations – The Method of Solutions of Successive Approximations and Picard's Theorem.

Unit IV: Oscillation Theory and Boundary value problems – Qualitative Properties of Solutions – Sturm Comparison Theorems – Eigen values, Eigen functions and the Vibrating String.

Unit V: Second Order P.D.E.: Genesis of Second Order P.D.E. – Classification of Second Order P.D.E. One-Dimensional Wave Equation – Vibrations of an Infinite String – Vibrations of a Semi-infinite String –Vibrations of a String of Finite Length (Method of separation of variables).

Text Books:

1.G.F. Simmons, **Differential Equations with Applications and Historical Notes**, TMH, New Delhi, 1984.

Unit I Chapter 3: Sections 15, 16, 19 and Chapter 5: Sections 25 to 27
Unit II Chapter 5: Sections 28 to 31 and Chapter 6: Sections 32 to 35
Unit III Chapter 7: Sections 37, 28 and Chapter 11: Sections 55, 56
Unit IV Chapter 4: Sections 22 to 24

2.T.Amarnath, **An Elementary Course in Partial Differential Equations**, Narosa Publishing Company, 1997.

Unit V : Chapter 2: Sections 2.1 to 2.3.5, except 2.3.4 In book 2

Reference Books:

1. W.T. Reid, Ordinary Differential Equations, John Wiley & Sons, New York, 1971.
2. E.A. Coddington, An Introduction to Ordinary Differential Equation, Prentice Hall of India, New Delhi, 2007.
3. D.Somasundaram, Ordinary Differential Equations, Narosa Publ., House, Chennai - 2002.
4. I.C. Evans, Partial Differential Equations, Graduate Studies in Mathematics, Vol. 19 AMS, 1998.
5. I.N. Snedden, Elements of Partial Differential Equations, McGraw Hill, 1985.

pedagogy :

Chalk & talk, PPT, Group discussion, Seminar, Quiz, assignment and video Lecture

***

Semester I

Course Code	Course Name	Category	L	T	P	Credit
PMTT14	**GRAPH THEORY**	**Core**	**86**	**4**	**-**	**5**

Objectives:

- **To impart the different types of graphs.**
- **To give a depth knowledge about matching and colourings.**
- **To make the students to identify the varieties of graphs.**
- **To study related theorems.**
- **To present students the Basic concepts of graph theory. To enable the students to find the practical applications to the real world problems etc.**

Course Outcomes: Upon the successful completion of the course, students will be able to

Course Outcomes:

CO1: State all of the technical definitions covered in the course (such as a graph, tree, planar graph, colouring, digraph, generating function, linear extension, and other terms).

CO2: State all of the relevant theorems covered in the course.

CO3: Formulate graph theoretic models to solve real world problems (e.g., scheduling problems).

CO4: Analyze combinatorial objects satisfying certain properties and answer questions related to existence (proving the existence or non-existence of such objects), construction (describing how to create such objects in the case they exist), enumeration (computing the number of such objects), and optimization (determining which objects satisfy a certain extremal property).

CO Number	CO Statement	Knowledge Level
CO1	Understanding of some network and colouring in Graph ns	K2
CO2	Apply the understanding and used to model the atomic variable	K3
CO3	Apply the concepts of connectivity, Blocks and Hamilton cycles in the real life.	K4
CO4	Demonstrate the concept and familiar with the concepts of colouring develop the reader to apply in day today life .	K5

Mapping with Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	M	S
CO2	S	M	M	S	S
CO3	S	S	S	S	M
CO4	M	S	M	S	S

S- Strong; M-Medium; L-Low

PMTT14 GRAPH THEORY 6Hours / 5 Credits

Unit I: Graphs, Subgraphs and Trees**:** Graphs and simple graphs – Graph isomorphism – The incidence and Adjacency matrices – subgraphs vertex degrees – paths and connection – cycles – Trees – Cut edges and bonds – Cut vertices – Cayley's formula.

Unit II: Connectivity, Euler Tours and Hamilton Cycles: Connectivity – Blocks – Euler tours – Hamilton cycles – The Chinese postman problem – The travelling salesman problem.

Unit III: Matchings and Edge Colourings: Matchings - matchings and coverings in bipartite graphs – Perfect matchings – Edge chromatic number - Vizing's theorem.

Unit IV: Independent Set, Cliques and Vertex Colourings**:** Independent sets – Ramsey's theorem – Turan's theorem – Chromatic number – Brooks theorem – Hajos theorem Chromatic polynomials – Girth and chromatic number.

Unit V: Planar Graphs And Directed Graphs **:** Plane and planar graphs – Dual graphs – Euler's formula – Bridges - Kuratowski's theorem – The five colour theorem and the four colour

conjecture – Non Hamiltonian planar graphs – Directed graphs – Directed paths – Directed cycles.

Text Book:
J. A. Bondy and U. S. R. Murty, **Graph theory with applications**, The MacMillan Press Ltd., 1976.

Unit I : (chapter 1 : 1.1 – 1.7 and chapter 2 : 2.1 – 2.4).
Unit II : (chapter 3 : 3.1 – 3.2 and chapter 4 : 4.1 – 4.4).
Unit III: (chapter 5 : 5.1 – 5.3 and chapter 6 : 6.1 – 6.2).
Unit IV: (chapter 7 : 7.1 – 7.3 and chapter 8 : 8.1 – 8.5).
Unit V : (chapter 9 : 9.1 – 9.7 and chapter 10 : 10.1 – 10.3).

Reference Books:

1. F.Harary, "Graph Theory", Addition Wesley, 1969
2. R. Johnson baurgh, "Discrete Mathematics", 1989
3. Narsingh Deo, Graph Theory with applications to Engineering and Computer Science, PHI learning Pvt Ltd, New Delhi, 2013
4. L.R. Foulds, "Graph Theory Applications", Narosa publishing House, 1993.

*****

pedagogy :

Chalk & talk, PPT, Group discussion, Seminar, Quiz, assignment and video Lecture

Semester II

Course Code	Course Name	Category	L	T	P	Credit
PMTT21	ALGEBRA	Core	86	4	-	5

Objectives:

- **To Provide deep knowledge about various algebraic Structures.**
- **Specific outcome learning: The learner will be able to recognize some advances of the theory of groups.**
- **Use Sylow's Theorems in the study of finite groups.**
- **Formulate some special types of rings and their properties.**
- **Recognize the interplay between fields and vector spaces. Apply the algebraic methods for solving Problems.**

Course Outcomes: Upon the successful completion of the course, students will be able to

CO1: Students will have a working knowledge of important mathematical concepts in abstract algebra such as definition of a group, order of a finite group and order of an element.

CO2: Students will be introduced to and have knowledge of many mathematical concepts studied in abstract mathematics such as permutation groups, factor groups and Abelian groups.

CO3: Students will actively participate in the transition of important concepts such homomorphisms & isomorphisms from discrete mathematics to advanced abstract mathematics.

CO4: Students will gain experience and confidence in proving theorems. A blended teaching method will be used requiring the students to prove theorems give the student the experience, knowledge, and confidence to move forward in the study of mathematics.

CO Number	CO Statement	Knowledge Level
CO1	Demonstrate competence with the basic ideas of algebra including the concepts of direct products, finitely generated abelian groups, Fields , extension fields , Galois theory and finite fields	K2
CO2	Demonstrate knowledge of the structures of fields ,extension fields and finite fields	K3
CO3	Apply the knowledge in solving problems in polynomials over the rational field	K4
CO4	Present clear and logical mathematical arguments and Solvability by radicals	K5

Mapping with Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	S	S
CO2	S	S	S	S	S
CO3	S	M	S	M	S
CO4	S	S	S	S	S

S- Strong; M-Medium; L-Low

Semester II

PMTT21 ALGEBRA 6 Hours/5 Credits

Unit I: A Counting principle - Normal subgroups and quotient groups - Homomorphism- Automorphism- Cayley's theorem - Permutation groups.

Unit II: Another counting principle - Sylow's theorem's - Direct product - Finite abelian groups.

Unit III: Euclidean rings - A Particular Euclidean ring - Polynomial rings - polynomials over the rational field - polynomial rings over commutative rings.

Unit IV: Extension fields - Roots of polynomials - More about roots - Finite fields.

Unit V:The elements of Galois theory – Solvability by radicals - Galois group over the rational.

Text book:

N. Herstein, **Topics in Algebra**, 2nd edition, John Wiley & Sons, Singapore, 2006.
Unit 1 Chapter 2: Sections 2.5, 2.6, 2.7, 2.8, 2.9, 2.10
Unit 2 Chapter 2: Sections 2.11, 2.12, 2.13, 2.14
Unit 3 Chapter 3: Sections 3.7, 3.8, 3.9, 3.10, 3.11
Unit 4 Chapter 5: Sections 5.1, 5.3, 5.5 & Chapter 7: Section 7.1
Unit 5 Chapter 5: Sections 5.6, 5.7, 5.8.

Reference Books:

1.John. B. Fraleigh, A First Course in Abstract Algebra, 7th Edition, Addison-Wesley, New Delhi, 2003.
2.P. B. Bhattacharya, S. K. Jain & S. R. Nagpaul, Basic Abstract Algebra, Cambridge University Press, USA, 1986.
3.Charles Lanski, Concepts in Abstract Algebra, American Mathematical Society, USA, 2010.

*****

pedagogy :

Chalk & talk, PPT, Group discussion, Seminar, Quiz, assignment and video Lecture

Semester II

Course Code	Course Name	Category	L	T	P	Credit
PMTT22	REAL ANALYSIS-II	Core	86	4	-	5

Objectives:

- **To introduce the concept of integration of real-valued functions.**
- **To give a deep knowledge about the real valued function.**
- **To know about linear transformation.**
- **To solve the problems of differentiation of integrals.**

Course Outcomes: Upon the successful completion of the course, students will be able to

CO1: Investigate the ideas of continuity and inverse images of open and closed sets, functions continuous on compact sets

CO2: Differentiate the concepts of connectedness and implement them on various sets.

CO3: Examine the derivatives of functions and apply few theorems based on it.

CO4: Investigate properties of monotonic functions.

CO5: Learn the properties of Riemann- Stieltjes integral.

CO Number	CO Statement	Knowledge Level
CO1	**Describe fundamental properties of the real numbers that lead to the formal development of real analysis**	K2
CO2	**Comprehend rigorous arguments developing the theory underpinning real analysis in the Stone-Weierstrass th**eorem	K3
CO3	**Demonstrate an understanding of limits and how they are used in sequences, series, differentiation and integration**	K4
CO4	**Construct various mathematical proofs of basic results in** implicit function theorem	K5
CO5	**Appreciate how abstract ideas and various methods in mathematical analysis can be applied to important practical problems. Exhibits rigorous mathematical proofs in real analysis like inverse function theorem and the implicit function theorem**	K6

Mapping with Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	M	S

CO2	**S**	**S**	**S**	**S**	**S**
CO3	**S**	**S**	**M**	**S**	**M**
CO4	**S**	**M**	**S**	**S**	**S**
CO5	**S**	**S**	**M**	**S**	**S**

S- Strong; M-Medium; L-Low

PMTT22 REAL ANALYSIS-II 6 Hours/5 Credits

Unit I: The Riemann-Stieltjes integral: Definition and existence of the integral - Properties of the integral - Integration and differentiation - Integration of vector valued functions - Rectifiable curves.

Unit II: Sequences and series of functions: Discussion of Main problem - Uniform Convergence - Uniform convergence and continuity - Uniform convergence and Integration - Uniform convergence and differentiation - Equicontinuous families of functions - The Stone-Weierstrass theorem.

Unit III: Some special functions: Power series - The exponential and Logarithmic functions - The trigonometric functions - The algebraic completeness of the complex field - Fourier Series - The Gamma functions.

Unit IV: Functions of several variables: Linear transformations – Differentiation - The contraction principle - The inverse function theorem.

Unit V: The **implicit** function theorem - The rank theorem – Determinants - Derivatives of higher order - Differentiation of integrals.

Text book:
Walter Rudin, **Principles of Mathematical Analysis**, 3rd Edition, McGraw – Hill International Book Company, Singapore, 1982.
Unit 1: Chapter 6, Unit 2: Chapter 7,
Unit 3: Chapter 8, Unit 4, 5: Chapter 9.

References Books:

1. Tom M. Apostol, Mathematical Analysis, Narosa Publishing House, New Delhi, India, 1997.
2. G. F. Simmons, Introduction to Topology and Modern Analysis, 3rd Ed., McGraw-Hill, New Delhi, 2004.
3. S. C. Malik, Mathematical Analysis, Willey Eastern Ltd., New Delhi, 1985.
4. N. L. Carothers, Real Analysis, Cambridge University Press, UK, 2000.

*****

pedagogy :

Chalk & talk, PPT, Group discussion, Seminar, Quiz, assignment and video Lecture

Semester II

Course Code	Course Name	Category	L	T	P	Credit
PMTT23	TOPOLOGY	Core	86	4	-	5

Objectives:

- **Students will learn the fundamental concepts of point-set topology**
- **Introduce students to the concepts of open and closed sets abstractly, not necessarily only on the real line approach**
- **Provide the awareness of tools to students to carrying out advanced research work in pure mathematics Course**

Course Outcomes: Upon the successful completion of the course, students will be able to

CO1: Know how the topology on a space is determined by the collection of open sets, by the collection of closed sets, or by a basis of neighbourhoods at each point, and you know what it means for a function to be continuous.

CO2: Know the definition and basic properties of connected spaces, path connected spaces, compact spaces, and locally compact spaces.

CO3: Know what it means for a metric space to be complete, and you can characterize compact metric spaces.

CO4: Familiar with the Urysohn lemma and the Tietze extension theorem, and you can characterize metrizable spaces.

CO5: Familiar with the construction of the fundamental group of a topological space and applications to covering spaces and homotopy theory.

CO Number	CO Statement	Knowledge Level
CO1	Define and illustrate the concept of topological spaces and continuous functions, concept of product topology and quotient topology	K2
CO2	Identify the concepts of distance between two sets, connectedness, denseness, compactness and separation axioms.	K3
CO3	Analyze the concepts to read and write theorem proofs in topology	K4
CO4	Ability to determine that a given point in a topological space is either a limit point of not for a given subset of a	K5

	topological space.	
CO5	**Apply theorem proofs to do variety of examples and counter examples in topology**	**K5**

Mapping with Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	**S**	**S**	**S**	**M**	**S**
CO2	**S**	**S**	**S**	**S**	**S**
CO3	**S**	**S**	**M**	**S**	**M**
CO4	**S**	**M**	**S**	**S**	**S**
CO5	**S**	**S**	**M**	**S**	**S**

S- Strong; M-Medium; L-Low

PMTT23 TOPOLOGY 6 Hours/5 Credits

Unit I:Topological Spaces and Continuous Functions: Topological spaces- Basis for a Topology- The order Topology- The Product Topology on X×Y- The subspace Topology – Closed sets and Limit points- Continuous Functions- The product Topology.

Unit II: Metric Topology: The Metric Topology- The Metric Topology (continued) Connectedness and Compactness: Connected Spaces- Connected Subspaces of the Real line- Components and Local Connectedness.

Unit III: Compactness: Compact Spaces- Compact subspaces of the Real Line- Limit Point Compactness- Local Compactness.

Unit IV: Countability and Separation Axioms: - The Separation Axioms- Normal Spaces- The Urysohn Lemma- The Urysohn Metrization Theorem.

Unit V: Extension Theorem: - The Tietze Extension Theorem- The Tychonoff Theorems- The Stone-Cech Compactification- Metrization Theorems: Local finiteness- The Nagata-Smirov Metrization Theorem

Text Book:

James. R. Munkres, **Topology: A first course**, 2nd Edition, Prentice Hall of India Pvt Ltd, New Delhi. 2013

Unit I: Chapter 2- Section: 12- Section 19

Unit II: Chapter 2- Section: 20, 21 and Chapter 3-Section: 23- Section: 25

Unit III: Chapter 3- Section: 26- Section 29

Unit IV: Chapter 4- Section: 30- Section 34
Unit V: Chapter 5- Section: 37, 38- Chapter 6: Section 39, 40

Reference Books:

1. G.F. Simmons "Introduction to Topology and modern Analysis", Tata McGraw Hill edition. B. Mendelson, Introduction to Topology, CBS Publishers, Delhi, 1985.
2. Size- Tsen Hu, Introduction to General Topology, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 1966.
3. S. Lipschutz, General Topology, Schaum's Series, McGraw-Hill New Delhi, 1965.
4. K. D. Joshi, Introduction to General Topology, New Age International Pvt. Ltd, 1983.
5. J. L. Kelly, General Topology, Springer-Verlag, New York, 1975

*****

pedagogy :

Chalk & talk, PPT, Group discussion, Seminar, Quiz, assignment and video Lecture

Semester II

Course Code	Course Name	Category	L	T	P	Credit
PMTT24	OPTMIZATION TECHNIQUES	Core	86	4	-	5

Objectives:

- **Ability to understand and analyze managerial problems in industry so that they are able to use resources (capitals, materials, staffing, and machines) more effectively;**
- **Provides a quantitative technique or a scientific approach for making better decisions for operations under the control.**
- **Use integer programming programming problem to solve system of linear equations.**
- **.To provide the depth knowledge about inventory control theory and make students to solve the inventory problems.**

Course Outcomes: Upon the successful completion of the course, students will be able to

CO1: The students will be able to analyze the real life systems with limited constraints

CO2: Identify the mathematical nature of a given optimization problem

CO3: Analyze a range of classes of optimization problems

CO4: Identify solution methods for the optimization problems studied

CO5: The students will be able to depict the systems in a mathematical model form.

CO Number	CO Statement	Knowledge Level
CO1	Recognize the importance and value of Operations Research and mathematical modeling in solving practical problems in industry	K2
CO2	Know how to use variables for formulating complex mathematical models in management science, industrial engineering and Transportation science and in real life.	K3
CO3	Analyze a managerial decision problem and application of Dynamic Programming: Capital Budgetting Problem	K4
CO4	To design, improve and operate complex systems in the best possible way through empirical Queueing Models	K5
CO5	Appreciate the significance of Lagrangean Method – Kuhn-Tucker Method	K6

Mapping with Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	S	S
CO2	S	S	S	M	S
CO3	S	S	S	S	S
CO4	S	S	M	S	S
CO5	S	S	S	S	M

S- Strong; M-Medium; L-Low

PMTT24 OPTMIZATION TECHNIQUES 6 Hours/5 Credits

Unit I: Integer Programming: Introduction – Integer Programming Formulations – The Cutting – Plane Algorithm – Branch-and-Bound Technique – Zero-One Implicit Enumeration Algorithm.

Unit II: Inventory Control: Introduction – Models of Inventory – Operation of Inventory System – Quantity Discount – Implementation of Purchase Inventory Model.

Unit III: Dynamic Programming: Introduction – Application of Dynamic Programming: Capital Budgetting Problem – Reliability Improvement Problem – Stage-coach Problem – Cargo Leading Problem – Minimizing Total Tardiness in Single Machine Scheduling Problem – Optimal Subdividing Problem – Solution of Linear Programming Problem through Dynamic Programming.

Unit IV: Queueing Theory: Introduction – Terminologies of Queueing System – Empirical Queueing Models – Simulation.

Unit V: Non Linear Programming: Introduction – Lagrangean Method – Kuhn-Tucker Method – Quadratic Programming – Separable Programming – Chance-Constrained Programming or Stochastic Programming.

Text Books:

R. Panneerselvam, **Operations Research**, 2nd Edition, PHI Learning Private Limited, Delhi, 2015.

Unit - I- Chapter 6- Sections 6.1-6.5
Unit - II- Chapter 7- Sections 7.1-7.5
Unit - III- Chapter 8- Sections 8.1-8.2
Unit - IV- Chapter 9- Sections 9.1-9.4
Unit - V- Chapter 17- Sections 17.1-17.6

Reference Books:

1. S. Kalavathy, Operations Research, fourth edition, Vikas Publishing House Pvt. Ltd.
2. G. Srinivasan, Operations Research principles and applications, Second Edition, PHI Learning Private Limited, New Delhi-110001, 2012.
3. Kanti Swarup, P.K. Gupta, Man Mohan, Operations Research, Sultan Chand & Sons, Educational Publishers, New Delhi.

*****

pedagogy :

Chalk & talk, PPT, Group discussion, Seminar, Quiz, assignment and video Lecture

Semester III

Course Code	Course Name	Category	L	T	P	Credit
PMTT31	COMPLEX ANALYSIS	Core	86	4	-	5

Objectives:

- **To impart various concepts about the sequence and series, analytic functions in the complex plane.**
- **Provide deep knowledge about mapping and transformation. and the learner will gain knowledge of power series of analytic function**

- **learner will be proficient in applications of Cauchy's theorem**
- **.To present students the elements and importance of the Complex analysis**.
- .To define and recognize the basic properties of the complex numbers.

Course Outcomes: Upon the successful completion of the course, students will be able to

CO1: Explain and apply Cauchy's integral formula and some of its consequences

CO2: explain the convergence of power series and develop analytical capabilities in Taylor or Laurent series in a given domain

CO3: Define the fundamental concepts of complex numbers and its properties, Exponential, logarithmic, trigonometric and hyperbolic complex functions .

CO4: Describe Holomorphic and harmonic complex functions and list different examples.

CO5: State Complex integral on a path – Cauchy theorem and Cauchy integral formula name zeros and singularities of a Complex function and the Residue theorem .

CO Number	CO Statement	Knowledge Level
CO1	Describe fundamental properties of the complex numbers that lead to the development of complex analysis	K2
CO2	Evaluate line integrals, curve integrals, singularities and determine the values of integrals using residues. ns	K3
CO3	Apply and understand about limits and to know how they are used in series and problems	K4
CO4	Analyze functions of complex variable in terms of continuity, differentiability and analyticity. Apply Cauchy-Riemann equations and harmonic functions to solve problem	K5
CO5	Comprehend rigorous arguments developing the theory underpinning complex analysis	K6

Mapping with Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	M	S
CO2	S	S	S	S	S
CO3	S	S	M	S	M
CO4	S	M	S	S	S
CO5	S	S	M	S	S

S- Strong; M-Medium; L-Low

PMTT31 COMPLEX ANALYSIS 6 Hours / 5 Credits

Unit I: Functions, Limit, and continuity: Sequence and series functions – limits and continuity-projection – sequence and series of function.

Unit II: Analytic functions and power series: Differentiability and Cauchy-Riemann equations – Harmonic functions- power series as and Analytic functions – Exponential and Trigonometric functions – Logarithmic functions – Inverse functions.

Unit III: Complex Integration: Plane – properties –Cauchy-Goursat Theorem – connectivity – Winding number –Homotopy version of Cauchy's theorem – Cauchy integral formula-Morera's theorem.

Unit IV: Mapping and Transformation: Existence of Harmonic Conjugate –Taylor's Theorem –Zeros of Analytic functions- Laurent serious –Principle of conformal mapping- Möbius map-fixed point and Möbius map.

Unit V: Maximum principle, Schwarz' Lemma – Liouville's Theorem: Maximum Modulus principle – Hadamard's Three circles/lines theorem – Schwarz' Lemma and its consequence-Liouville's Theorem- Doubly periodic entire functions – fundamental theorem of Algebra – Zeros of certain Polynomials.

Text book:

S.Ponnusamy, Foundations of Complex Analysis, 2rd Edition, Narosa Publishing House Ltd, Chennai, 2005.
Unit I - Chapter 1: 1.6 and Chapter 2: 2.1 – 2.4
Unit II – Chapter 3: 3.1 – 3.6
Unit III - Chapter 4: 4.1 – 4.8
Unit IV- Chapter 4: 4.9 –4.12 and Chapter 5: 5.1-5.3
Unit V – Chapter 6: 6.1 – 6.7

Reference Books:

1. John B. Conway "Function of one Complex Variable" 2ndEdition,Springers International Students Edition.
2. Karunakaran, Complex Analysis, Narosa Publishing House, New Delhi, 2002.
3. R.V. Churchill & J. W. Brown, Complex Variables & Applications, Mc.Graw Hill,1990.

4. John. B. Conway, Functions of One Complex Variable, Narosa Pub. House, 2002.
5. Lars V. Ahlfors, Complex Analysis, Third Ed. McGraw-Hill Book Company, Tokyo, 1979.

*****

pedagogy :

Chalk & talk, PPT, Group discussion, Seminar, Quiz, assignment and video Lecture

Semester III

Course Code	Course Name	Category	L	T	P	Credit
PMTT32	MEASURE THEORY	Core	86	4	-	5

Objectives:

- **To introduce concepts of outer measures and integration on R and to develop the concept of analysis in abstract situations.**
- **Provide the relationship between Riemann and Lebesgue integral**
- **Learner will be derive integration and derivates by using Radon-Nikodym Theorem and Fubini's Theorem**
- **To introduce the concepts of measure and integral with respect to a measure, to show their basic properties, and to provide a basis for further studies in Analysis, Probability, and Dynamical Systems.**
- **To gain understanding of the abstract measure theory and definition and main properties of the integral.**
- **To construct Lebesgue's measure on the real line and in n-dimensional Euclidean space. To explain the basic advanced directions of the theory.**

Course Outcomes: Upon the successful completion of the course, students will be able to

CO1: Master in an abstract context, the fundamental theorems of integration learned during the previous courses of analysis for the case of the Euclidean spaces, harmonizing the latter with the example of the outer Lebesgue measure.

CO2: Build a measure starting from a countable additive set function defined on a semi-algebra of subsets or starting from a sequence of suitably chosen measures.

CO3: Integrate a measurable function with respect to a measure

O Number	CO Statement	Knowledge Level
CO1	**Describes the basics axioms for the real numbers, natural and rational numbers as subset. Demonstrate the basic concepts underlying the definition of the general Lebesgue integral**	K2

CO2	**Derives the concepts of Borel sets, measurable functions, differentiation of monotone functions**	**K3**
CO3	**Analyse about the Signed Measure and the Hahn Decomposition, integral of a non-negative function, functions of bounded variation**	**K4**

Mapping with Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	**S**	**S**	**S**	**S**	**S**
CO2	**S**	**S**	**S**	**M**	**S**
CO3	**S**	**S**	**S**	**S**	**S**

S- Strong; M-Medium; L-Low

Semester III

PMTT32 MEASURE THEORY 6Hours/5 Credits

Unit I: Lebesgue Measure**:** Lebesgue Outer Measure - Measurable Sets – Regularity – Measurable Functions - Borel and Lebesgue Measurability.

Unit II: Borel and Lebesgue Measure: Integration of Non-Negative Functions – General Integral. Integration of series – Riemann and Lebesgue Integral.

Unit III: R-S Integral: Abstract Measures space – Measures and Outer Measures- Extension of a Measure – Uniqueness of Extension - Completion of a Measure – Measure Spaces – Integration with respect to a Measure – L^p Spaces – Completeness.

Unit IV: Signed Measure: Signed Measure and the Hahn Decomposition – the Jordan Decomposition – Radon-Nikodym Theorem.

Unit V: Measurability in a Product Space – The Product Measure and Fubini's Theorem.

Text Book

G.De Barra, **Measure Theory and Integration**, 1st edt, New age international (p) Limited, 2003

Unit – I: Chapter II: Sections 2.1 to 2.5
Unit – II: Chapter III: Sections 3.1 to 3.4
Unit – III: Chapter V: Sections 5.1 to 5.6
Unit – IV: Chapter VII: Sections 7.1 and 7.2, Chapter VIII: Sections 8.1 and 8.2
Unit – V: Chapter X: Sections 10.1 and 10.2

Reference Books:

1. P.R. Halmos, "Measure Theory", D.VanNostrand Company, Inc. Princeton, N.J., 1950
2. H.L.Royden "Real Analysis", Prentice Hall of India 2001 edition.

3. I.K. Rana, An Introduction to Measure and Integration, Narosa Publishing House, NewDelhi, 1999
4. D.L. Cohn, Measure Theory, Birkhauser, Switzerland, 1980,

****

pedagogy :

Chalk & talk, PPT, Group discussion, Seminar, Quiz, assignment and video Lecture

Semester III

Course Code	Course Name	Category	L	T	P	Credit
PMTT33	CLASSICAL DYNAMICS	Core	86	4	-	5

Objectives:

- **1.To develop familiarity with the physical concepts and facility with the mathematical methods of classical dynamics**
- **To represent the equations of motion for complicated mechanical systems using the Lagrangian and Hamiltonian formulation of classical dynamics**

Course Outcomes: Upon the successful completion of the course, students will be able to

Course Outcomes:

CO1: Be able to solve the Lagrange's equations for simple configurations using various methods.

CO2: Understand the concept of Hamilton Jacobi Theory.

CO3: Be able to understand the concept canonical Transformations

CO4: **To develop skills in formulating and solving physics problems**

CO5: Able to get idea of dynamical systems are of relatively recent origin, the concept of motion in phase- space and its geometrical depiction is simple.

CO Number	CO Statement	Knowledge Level
CO1	Demonstrate the knowledge of core principles in dynamics	K2
CO2	Interpret complex and difficult problems of classical dynamics in a systematic way	K3
CO3	Apply the variation principle for real physical situations	K4

CO4	**Identify the existing symmetries and the corresponding integrals of motion and analyze the qualitative nature of dynamics**	**K5**
CO5	**Explore problem solving skills (approach, estimation, computation, and analysis) of classical mechanics in various contexts such as mechanical engineering, astrophysics, and biophysics**	**K6**

Mapping with Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	**M**	**S**	**S**	**S**	**M**
CO2	**S**	**S**	**S**	**M**	**S**
CO3	**S**	**S**	**M**	**S**	**S**
CO4	**S**	**M**	**S**	**S**	**S**
CO5	**S**	**S**	**S**	**S**	**M**

S- Strong; M-Medium; L-Low

PMTT33 CLASSICAL DYNAMICS 6 Hours/5 Credits

.

Unit I: Introductory concepts: The mechanical system - Generalised Coordinates - constraints - virtual work - Energy and momentum.

Unit II: Lagrange's equation: Derivation and examples - Integrals of the Motion

Unit III: Hamilton's equations: Hamilton's principle - Hamilton's equations - Other variational principles - phase space.

Unit IV: Hamilton - Jacobi Theory: Hamilton's Principal Function – The Hamilton - Jacobi equation - Separability.

Unit V: Canonical Transformations: Differential forms and Generating functions – Special Transformations – Lagrange and Poisson Brackets.

Text Book:

Donald T. Greenwood, **Classical Dynamics**, PHI Pvt. Ltd., New Delhi, 1985.
Unit I - Chapter: 1.1-1.5

Unit II - Chapter: 2.1-2.4
Unit III - Chapter: 3.1,3.2 and 3.4 (3.3 Omitted)
Unit IV - Chapter: 4.1-4.4
Unit V - Chapter: 5.1-5.3

Reference Books:

1.H. Goldstein, Classical Mechanics, (2nd Edition), Narosa Publishing House, New Delhi, 1998.
2.John L Synge and Byron A Griffith, Priniciples of Mechanics, McGraw-Hill, New York, 1959.
3.Narayan Chandra Rana &Promod Sharad Chandra Joag, Classical Mechanics, Tata McGraw Hill, 1991.

pedagogy :

Chalk & talk, PPT, Group discussion, Seminar, Quiz, assignment and video Lecture

Semester III

Course Code	Course Name	Category	L	T	P	Credit
PMTT34	CALCULUS OF VARIATIONS AND INTEGRAL EQUATIONS	Core	86	4	-	5

Objectives:

- **To introduce the concept of calculus of variations and integral equations and their applications for fixed boundaries.**
- **To give a knowledge about a calculations variation and make students to solve the problems.**
- **To study linear integral problems and methods of successive approximations.**
- **Learner will be able solve problems based on these topics**.

Course Outcomes: Upon the successful completion of the course, students will be able to

CO1: Determine asymptotes for rational expressions (we will not go into these graphs in much detail)

CO2: Apply the techniques from the previous section to graph a fourth degree polynomial or higher

CO3: On successful completion of the course students will be able to recognize difference between Volterra and Fredholm Integral Equations, First kind and Second kind, homogeneous and inhomogeneous etc.

CO4: They apply different methods to solve Integral Equations.

CO Number	CO Statement	Knowledge Level
CO1	**Demonstrate competence with the basic ideas of The Method of Variations in Problems with fixed Boundaries**	K2
CO2	**Become familiar with** f**unctional dependent on the functions of several independent variables**	K3
CO3	**Apply Euler's** finite difference method ,The Ritz method and Kantorovich's method **in Variational Problems**	K4
CO4	**Compose clear and accurate proofs using the concepts of reduction to a system of Algebraic equa**tions	K5

Mapping with Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	S	S
CO2	S	S	S	M	S
CO3	S	S	S	S	S
CO4	S	S	M	S	S

S- Strong; M-Medium; L-Low

Semester III

PMTT34 CALCULUS OF VARIATIONS AND INTEGRAL EQUATIONS **6Hours/5 Credits**

.Unit-I: The Method of Variations in Problems with fixed Boundaries

Variation and its properties - Euler's equation - Functionals of the form $\int F(x,y_1,y_2,\ldots y_n,y_1',y_2',\ldots y_n')dx$, Functionals dependent on higher order derivatives - Functionals dependent on the functions of several independent variables - Variational problems in parametric form - Some applications.

Unit-II: Sufficient Conditions for an Extremum

Field of extremals - The function E(x,y,p,y') - Transforming the Euler equations to the canonical form.

Unit-III: Direct Methods in Variational Problems

Direct methods - Euler's finite difference method - The Ritz method - Kantorovich's method.

Integral Equations:

Unit IV: Linear Integral Equations - Definition, Regularity conditions – special kind of kernels – eigen values and eigen functions – convolution Integral – the inner and scalar product of two functions – Notation – reduction to a system of Algebraic equations – examples – Fredholm alternative - examples – an approximate method.

Unit V: Method of successive approximations: Iterative scheme – examples – Volterra Integral equation – examples – some results about the resolvent kernel. Classical Fredholm Theory: the method of solution of Fredholm – Fredholm's first theorem – second theorem – third theorem.

Text Books:

1. L. Elsgolts, **Differential equations and the calculus of variations**, MIR publishers, Moscow 1970.

Unit – I Chapter 6
Unit – II Chapter 8
Unit – III Chapter 10

2.Ram.P.Kanwal, **Linear Integral Equations Theory and Practice**, Academic Press 1971.

[1] Unit – IV Chapters 1 and 2
Unit – V Chapters 3 and 4

Reference Books:

1.S.J. Mikhlin, Linear Integral Equations (translated from Russian), Hindustan Book Agency, 1960.
2.I.N. Snedden, Mixed Boundary Value Problems in Potential Theory, North Holland, 1966.

*****

pedagogy :

Chalk & talk, PPT, Group discussion, Seminar, Quiz, assignment and video Lecture

Semester IV

Course Code	Course Name	Category	L	T	P	Credit
PMTT41	**FUNCTIONAL ANALYSIS**	**Core**	**86**	**4**	**-**	**5**

Objectives:

- To introduce three structure theorems of Function as Hahn – Banach theorem, open
- mapping theorem and uniform boundedness principle from Hilbert space..
- To study the finite dimensional spectrum theory.

Course Outcomes: Upon the successful completion of the course, students will be able to

Course Outcomes:

CO1: To learn to recognize the fundamental properties of normed spaces and of the transformations between them.

CO2: To be acquainted with the statement of the Hahn-Banach theorem and its corollaries. To understand the notions of dot product and Hilbert space.

CO3: To apply the spectral theorem to the resolution of integral equations and Sturm-Liouville problems.

CO4: The learner will gain knowledge normed linear space, Banach spaces, Hahn-Banach theorem(open and closed) and (general and structure) banach algebra.

CO Number	CO Statement	Knowledge Level
CO1	**Describe properties of normed linear spaces and construct examples of such spaces**	K2
CO2	**Apply basic theoretical techniques to analyze linear functionals and operators on Banach and Hilbert spaces.**	K3
CO3	**Apply Finite-Dimensional Spectral Theory** survey of the situation	K4
CO4	**Apply theorems to do problems**	K5

Mapping with Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	S	S
CO2	S	S	S	M	S
CO3	S	S	S	S	S
CO4	S	S	M	S	S

S- Strong; M-Medium; L-Low

PMTT41 FUNCTIONAL ANALYSIS 6Hours/5 Credits

Unit I: Banach spaces: The definitions 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.

Unit II: Hilbert Spaces: The Definitions and some simple properties-Orthogonal Complements-Orthonormal sets-The Conjugate Space H^* - The Adjoint of an operator-Self-adjoint operators-Normal and Unitary operators.

Unit III: Finite-Dimensional Spectral Theory: Matrices – Determinants and the spectrum of an operator – The spectral theorem – A survey of the situation

Unit IV: General Preliminaries on Banach Algebras: The Definition and some examples-Regular and singular elements-Topological divisors of zero-The Spectrum-The formula for the spectrum radius-The radical and semi-simplicity.

Unit V:The Structure of Commutative Banach Algebras : The Gelfand mapping – Applications of the formula r(x) = lim || xn ||1/n - Involutions in Banach Algebras – The Gelfand-Neumark theorem.

Text Book:

G.F.Simmons "Introduction to Topology and Modern Analysis" ,Tata McGraw Hill Edn, 2004.

Unit I: Chapter 9 Unit II: Chapter 10

Unit III: Chapter 11 Unit IV: Chapter 12 Unit V:Chapter 13

Reference Books:

1. M. Thamban Nair, "Functional Analysis" Eastern Economy edition, Prentice Hall of India Pvt Ltd, New Delhi 2002.
2. B.V. Limaye, "Functional Analysis" Wiley Eastern New Delhi 1981.
3. Walter Rudin, Functional Analysis, TMH Edition, 1974.
4. B.V. Limaye, Functional Analysis, Wiley Eastern Limited, Bombay, Second Print,1985.
5. K.Yosida, Functional Analysis, Springer-Verlag, 1974.

****

pedagogy :

Chalk & talk, PPT, Group discussion, Seminar, Quiz, assignment and video Lecture

Semester IV

Course Code	Course Name	Category	L	T	P	Credit
PMTT42	DIFFERENTIAL GEOMETRY	Core	86	4	-	5

Objectives:

- **To introduce space curves, surfaces and its properties.**
- **The learner will acquire knowledge in problem solving in curves and surfaces in geometrical approach.**
- **To make the students to solve the problems based on these topics and to study Representation of a surface, geodesic equations and geodesic curvatures**

Course Outcomes: Upon the successful completion of the course, students will be able to

CO1: After completing this course, students should be able to: Determine and calculate curvature of curves in different coordinate systems.

CO2: Treat geodesic curves and parallel translation Calculate and analysis curvature of surfaces in different settings.

CO3: Know the concept of tensor and recognize tensors that are used in mechanics, image processing and theory of relativity.

CO4: Apply geometry of curves and surfaces to computer aided graphics.

CO Number	CO Statement	Knowledge Level
CO1	Make clear and concise arguments involving basic notions and constructions of 2-dimensional Riemannian geometry, curves and torsion	K2
CO2	Identification of important types of curves in surfaces, including principal curves, asymptotic curves and geodesics using fundamental existence theorem for space curves	K3
CO3	Enumerate some standard examples in geometry, such as surfaces of constant Gaussian curvature, compact and non - compact surfaces, and surfaces of revolution	K4
CO4	Analyze Gaussian and mean curvatures using variety of methods including patch computations .Differential equations of geodesics using normal property	K5

Mapping with Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	S	S
CO2	S	S	S	M	S

CO3	**S**	**S**	**S**	**S**	**S**
CO4	**S**	**S**	**M**	**S**	**S**

S- Strong; M-Medium; L-Low

PMTT42 DIFFERENTIAL GEOMETRY 6 Hours/5 Credits

.

Unit I: Theory of space curves: Unique parametric representation of a space curve- Arc length - tangent and osculating plane - principal normal and binormal - curvature and torsion - contact between curves and surfaces - osculating circle and osculating sphere - locus of centres of spherical curvature.

Unit II: Tangent surfaces - Involutes and evolutes- Betrand curves - Spherical indicatrix - Intrinsic equations of space curves - Fundamental existence theorem for space curves - Helices.

Unit III: The first fundamental form and local intrinsic properties of a surface: Definition of a surface - Nature of points on a surface - Representation of a surface - Curves on surfaces - Tangent plane and surface normal - The general surfaces of revolution – Helicoids - Metric on a surface - The first fundamental form - Direction coefficients on a surface.

Unit IV: Families of curves - Orthogonal trajectories - Double family of curves – Isometric correspondence - Intrinsic properties - Geodesics on a surface: Geodesics and their differential equations - Canonical geodesic equations - Geodesics on surface of revolution - Normal property of geodesics - Differential equations of geodesics using normal property.

Unit V: Existence theorems - Geodesic parallels - Geodesic polar coordinates – Geodesic curvature - Gauss-Bonnet theorem-Gaussian curvature.

Text Book:

D. Somasundaram, Differential Geometry: A first course, Narosa Publishing House, New Delhi, India, 2005.

Unit I: Sections 1.3-1.7, 1.10-1.12
Unit II: Sections 1.13-1.18
Unit III: Sections 2.2-2.10
Unit IV: Sections 2.11-2.15, 3.2-3.6
Unit V: Sections 3.7-3.12

Reference Books:

1. T.J. Willmore, An Introduction to Differential Geometry, Oxford University Press, New Delhi, 2006.
2. J. N. Sharma & A. R. Vasistha, Differential Geormetry, KedarNath Ram Nath, Meerut, 1998.
3. Dirk J. Struik: "Lectures on Classical Differential Geometry" (second edition), Addison Wesley Publishing Company.

*****

pedagogy :

Chalk & talk, PPT, Group discussion, Seminar, Quiz, assignment and video Lecture

Semester IV

PMTP43 **Project- Mathematical Model** **18 Hours/5 credits**

RULES AND REGULATION OF THE PROJECT

1. The Project Area/title must be any one of the following

   (i) Pure Mathematics
   (ii) Applied Mathematics
   (iii) Mathematical Application in Real Time Activities.
2. Student allotment Method will be decided by the Department Faculties(In October 2nd week)
3. They are Four Project Common Meet(In Front of All Faculty) Power point presentation
   (i). First Meet – November last week. Work done - Topic and Area will be decided (5 marks)
   (ii). Second Meet – January 1st week. Work done-25% work (5 marks)
   (iii). Third Meet –February 1st week, Work done -50% work(5 marks)
   (iv). Fourth Meet – March 1st week, work done -90% work(5 marks)
4. Project Record Submission – Third week of March

   Internal: 25 marks
   External: 75 marks

Course Code	Course Name	Category	L	T	P	Credit
Elective Papers 1	**ALGEBRAIC NUMBER THEORY**	**Elective**	**86**	**4**	**-**	**5**

Objectives:

- **To expose the students to the charm, niceties and nuances in the world of numbers.**
- **To highlight some of the Applications of the Theory of Numbers.**
- **The Learner will gain deep knowledge to solve the problems on algebraic number theory.**
- **The Learner will be know the various type of equations**

Course Outcomes: Upon the successful completion of the course, students will be able to

CO1: Demonstrate knowledge and understanding of topics including, but not limited to divisibility, prime numbers, congruence, quadratic reciprocity, Diophantine equations.

CO2: Learn methods and techniques used in number theory.

CO3: Write programs/functions to compute number theoretic functions.

CO4: Use mathematical induction and other types of proof writing techniques.

CO Number	CO Statement	Knowledge Level
CO1	**Demonstrate factual knowledge including the mathematical notation and terminology of number theory**	**K2**
CO2	**Construct mathematical proofs of statements and find counterexamples to false statements in Number Theory.**	**K3**
CO3	**Apply theoretical knowledge to problems of computer security**	

		K4
CO4	**Analyze the logic and methods behind the major proofs in number theory.**	**K5**

Mapping with Programme Outcomes

COs/Pos	PO1	PO2	PO3	PO4	PO5
CO1	**S**	**S**	**S**	**S**	**S**
CO2	**S**	**S**	**S**	**M**	**S**
CO3	**S**	**S**	**S**	**S**	**S**
CO4	**S**	**S**	**M**	**S**	**S**

S- Strong; M-Medium; L-Low

Elective Papers 1

6 Hours/5 Credits

ALGEBRAIC NUMBER THEORY

Unit I: Introduction – Divisibility – Primes – The Binomial Theorem – Congruences – Euler's totient - Fermat's, Euler's and Wilson's Theorems – Solutions of congruences – The Chinese Remainder theorem.

Unit II: Techniques of numerical calculations – Public key cryptography – Prime power Moduli – Primitive roots and Power Residues –Congruences of degree two.

Unit III: Number theory from an Algebraic Viewpoint – Groups, rings and fields – Quadratic Residues- The Legendre symbol (a/r) where r is an odd prime – Quadratic Reciprocity – The Jacobi Symbol (P/q) where q is an odd positive integer.

Unit IV: Binary Quadratic Forms – Equivalence and Reduction of Binary Quadratic Forms – Sums of three squares – Positive Definite Binary Quadratic forms – Greatest integer Function – Arithmetic Functions – The Mobius Inversion Formula – Recurrence Functions – Combinatorial number theory .

Unit V: Diophantine Equations – The equation ax+by=c – Simultaneous Linear Diophantine Equations – Pythagorean Triangles – Assorted examples.

Text Book

Ivan Niven, Herbert S, Zuckerman and Hugh L, Montgomery, **An Introduction to the Theory of Numbers**, 5th edn., John Wiley & Sons Inc, 2004.

Unit I Chapter 1 and Chapter 2 : Sections 2.1 to 2.3

Unit II Chapter 2 : Sections 2.4 to 2.9
Unit III Chapter 2 : Sections 2.10, 2.11 and Chapter 3: Sections 3.1 to 3.3
Unit IV Chapter 3 : Sections 3.4 to 3.7 and Chapter 4
Unit V Chapter 5: Sections 5.1 to 5.4.

Reference Books:

1. Elementary Number Theory, David M. Burton W.M.C. Brown Publishers, Dubuque, Lawa, 1989.
2. Number Theory, George Andrews, Courier Dover Publications,1994.
3. Fundamentals of Number Theory, William J. Leveque Addison-Wesley Publishing Company, Phillipines, 1977.

****

pedagogy :

Chalk & talk, PPT, Group discussion, Seminar, Quiz, assignment and video Lecture

Course Code	Course Name	Category	L	T	P	Credit
Elective Papers 2	**AUTOMATA THEORY**	**Elective**	**86**	**4**	**-**	**5**

Objectives:

- **To make the students to understand the nuances of Automata and Grammar.**
- **To explain various types of automata and grammar.**
- **Introduce the fundamental concepts of formal languages, grammars and automata theory.**
- **Identify different formal language classes and their relationships**
- **To make them to understand the applications of these techniques in computer science.**

Course Outcomes: Upon the successful completion of the course, students will be able to

CO1: Acquire a fundamental understanding of the core concepts in automata theory and formal languages.

CO2: An ability to design grammars and automata (recognizers) for different language classes.

CO3: An ability to identify formal language classes and prove language membership properties.

CO4: An ability to prove and disprove theorems establishing key properties of formal languages and automata.

CO5: To solve the sums based on automata and grammar.

CO Number	CO Statement	Knowledge Level
CO1	Understand basic concepts in Lattices , formal language and automata theory	K2
CO2	Demonstrate abstract models of computing, including deterministic (DFA), non-deterministic (NFA), Push Down Automata(PDA	K3
CO3	Apply theoretical knowledge relate practical problems to languages and automata	K4
CO4	Analyze the logic and methods behind grammars and recognizers for different formal languages	K5
CO5	Formalize the structure of a given formal language using regular expressions and context free grammars and implementation of a lexical analyzer.	K5

Mapping with Programme Outcomes

COs/Pos	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	S	S
CO2	S	S	S	M	S
CO3	S	S	S	S	S
CO4	S	S	M	S	S
CO5	S	S	S	S	M

S- Strong; M-Medium; L-Low

Elective Papers 2 AUTOMATA THEORY 6 Hours /Credits : 5

Unit I: Finite Automata and Regular expressions Definitions and examples - Deterministic and Nondeterministic finite Automata - Finite Automata with -moves.

Unit II: Context free grammar Regular expressions and their relationship with automation - Grammar - Ambiguous and unambiguous grammars - Derivation trees – Chomsky Normal form.

Unit III: Pushdown Automaton Pushdown Automaton - Definition and examples - Relation with Context free languages.

Unit IV: Finite Automata and lexical analysis Role of a lexical analyzer - Minimizing the number of states of a DFA - Implementation of a lexical analyzer.

Unit V: Basic parsing techniques Parsers - Bottom up Parsers - Shift reduce - operator precedence - Top down Parsers - Recursive descent - Predictive parsers.

Text Books:

1. John E. Hopcroft and Jeffrey D. Ullman, **Introduction to Automata theory, Languages and Computations**, Narosa Publishing House, Chennai, 2000.

Unit I: Chapter 2: Sections2.1-2.4
Unit II: Chapter 2, Section 2.5, Chapter 4, Sections 4.1-4.3, 4.5,4.6
Unit III: Chapter 5: Section 5.2, 5.3

2. A.V. Aho and Jeffrey D. Ullman, **Principles of Compiler Design**, Narosa Publishing House, Chennai, 2002.

Unit IV: Chapter 3: Section 3.1-3.8
Unit V: Chapter 5: Section 5.1-5.5

References Books:

1. Harry R. Lewis and Christos H. Papadimitriou, Elements of the Theory of Computation, Second Edition, Prentice Hall, 1997.
2. A.V. Aho, Monica S. Lam, R. Sethi, J.D. Ullman, Compilers: Principles, Techniques and Tools, Second Edition, Addison-Wesley, 2007.

*****

pedagogy :

Chalk & talk, PPT, Group discussion, Seminar, Quiz, assignment and video Lecture

Course Code	Course Name	Category	L	T	P	Credit
Elective paper 3	PROBABILITY THEORY AND STATISTICS	Elective	86	4	-	5

Objective

- **To learn the advanced theory of possibility and distributions and Estimations.**
- **To understand the concepts of probability and its properties.**
- **The learner identifying situations where one-way ANOVA and Latin squar*e***

Course Outcomes: Upon the successful completion of the course, students will be able to

CO1: Able to understand the concepts of various parameter estimation methods, like method of moments, maximum likelihood estimation and confidence intervals

CO2: Able to apply the appropriate Chi-Squared test for independence and goodness of fit

CO3: Students will frame problems using multiple mathematical and statistical representations of relevant structures and relationships and solve using standard techniques.

CO4: The learner to know constructing the probability distribution of a random variable based on the real-world situation and compute mean and variance and many distributions

CO Number	CO Statement	Knowledge Level
CO1	Demonstrate the basic concepts of statistics, probability and random variables	K2
CO2	Apply the concepts in finding the moments of the distributions.	K3
CO3	Identify the type of the distribution and estimation	K4
CO4	Understand the basics of sampling distribution theory	K5

Mapping with Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	S	S
CO2	S	S	S	M	S
CO3	S	S	S	S	S
CO4	S	S	M	S	S

Elective paper 3 PROBABILITY THEORY AND STATISTICS 6 Hours/ 5 Credits

.

Unit I: Theory of Probability: Axiomatic approach to axioms of Probability, Conditional probability – Multiplicative law of Probability -Total probability and Baye's theorem – Independent events. Discrete random variable - continuous random variables – Properties of distribution function-Function of random variable- Two dimension random variable - Marginal Probability Distributions – Conditional Probability Distributions- independent random variables.

Unit II: Moment Generating Function: Expectation – Moments -Moment Generating Function and properties - Characteristic Functions: Probability Generating Function-Correlation – Regression –Multiple and Partial Correlation.

Unit III: Distributions: Geometric Distribution -The Normal Distribution - Uniform Distribution – Exponential Distribution – Gamma Distributions - Beta Distributions- Sampling distribution - Chi Square, t, F Distribution – Students t Distribution – F-Distribution.

Unit IV: Estimation: Concepts of Point and Interval Estimator –Efficiency - Consistent Estimator –Sufficient Estimator – Properties of Estimator –invariance property of consistent estimator – method of Maximum Likelihood Estimators-Minimum chi square Estimator.

Unit V: Classifications: One way and two way classification -ANOVA- design of Experiments: Experimental Units –basic principles in the design of Experiments- Completely block designs - Completely Randomized Design -Randomized Block design – Latin square designs- analysis of Latin square designs- merits and demerits of Completely Randomized Design - merits and demerits of Random Block design and Latin square design –Factorial Experiments.

Text Books:

P.R.Vital , **Mathematical Statistics**, Margham publications, Edition 2012.
Unit I - Chapter 1: 1.4 – 1.48 and Chapter 2 : 2.1 – 2.33
Unit II- Chapter 3: 3.1 – 3.18, Chapter 5, Chapter 6, Chapter 8, Chapter 9 and Chapter 11
Unit III- Chapter 15, Chapter 16, Chapter 17, Chapter 18, Chapter 19,Chapter 20, and Chapter 22 Unit IV- Chapter 23 Unit V -Chapter 26 and Chapter 28.

Reference Books:

1.Robert V. Hogg & Allen T. Craig, Introduction to Mathematical Statistics, 5th Edition, Pearson Education, Singapore, 2002.
2.Irwin Miller &Marylees Miller, John E. Freund's Mathematical Statistics, 6th Edition, Pearson Education, New Delhi, 2002.
3. John E. Freund, Mathematical Statistics, 5 th edition, Prentice Hall India, 1994.
4.S.M. Ross, Introduction to Probability Models, Academic Press, India, 2000.

*****

pèdagogy :

Chalk & talk, PPT, Group discussion, Seminar, Quiz, assignment and video Lecture

Course Code	Course Name	Category	L	T	P	Credit
Elective paper 4	MATLAB & LATEX	Elective	86	4	-	5

Objective:

- **To impart the programming concepts of Matlab and Laxtex.**
- **Specific outcome of learning the learner will be able to use Matlab for interactive computations Able to draw 2D and 3D graphs.**
- **Understand richness of Latex rather than using algebraic Number theory M.S. Word for documentation**
- **Able to applying programming techniques to solve the programs at advanced level.**

Course Outcomes: Upon the successful completion of the course, students will be able to

CO1: Able to use Matlab for interactive computations.

CO2: Familiar with memory and file management in Matlab.

CO3: Able to generate plots and export this for use in reports and presentations.

CO4: Cooperating and working with others using subversion

CO5: Debugging and optimising their programs

CO Number	CO Statement	Knowledge Level
CO1	Demonstrate the basic concepts of types of mat lab mathematical operators,Relational, binary and logical operators	K2
CO2	Apply the concepts in expanding and reducing size-reshaping ,shifting and sorting matrices .	K3
CO3	Identify different types of LaTex and LaTex file	K4
CO4	Understand the basics of document layout and organization	K5
CO5	Emphasis on estimating a document class and fine tuning text .	K6

Mapping with Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5

CO1	**S**	**S**	**S**	**S**	**S**
CO2	**S**	**S**	**S**	**M**	**S**
CO3	**S**	**S**	**S**	**S**	**S**
CO4	**S**	**S**	**M**	**S**	**S**
CO5	**S**	**S**	**S**	**S**	**M**

S- Strong; M-Medium; L-Low

Elective paper 4 MATLAB & LATEX 6 Hours/5 Credits

Unit I Introduction- Starting –Closing matlab -Types of matlab windows - Data types - Asssignment statements. System commands and mathematical operators: Saving and loading files - Workspace - Mathematical operators -Relational, binary and logical operators.

Unit II: **Handling of arrays**: Creating- Accessing arrays - Mathematical operations on arrays: Addition, multiplication of single and multiple arrays -Relational and logical operations on arrays - Operations on sets. Handling of matrices: Creating - Accessing- Length-size- Maximaum -Minimum - Mean - Expanding and reducing size- Reshaping - Shifting -Sorting matrices -Mathematical operations on matrices.

Unit III: **LaTex:** Introduction - Components - messages - commands -Advantages- Text formatting - different types of LaTex- LaTex file- Commands name and arguments – environments – declarations lengths special characters – Fragile commands.

Unit IV: **Document layout and organization**: Document class – page style parts of the documents –Table of contents – fine tuning text – word division.

Unit V: **Displayed Text**: Chaning font – centering and indenting – lists- generalized list – declarations – tabulator stops – boxes – tables – printing literal – footnotes and marginal notes.

Text Books:

1. Y. Kirani Singh & B. B. Chaudhuri, **MATLAB Programming**, Prentice-Hall of India Pvt. Ltd, New Delhi, 2008.(Unit I , Unit II)

2. H.Kopaka, and P.W.Daly, **Guide to LaTex**, 3rd edition,Addition Wesley, London,1999(Unit III- Chapter 1&2, Unit IV- Chapter 3,Unit V-Chapter4)

Reference Books:

1.Desmond. J.Higham &Nicholas J.Hiham,MATLAB Guide , 2nd edition SIAM , 2005.
2.H.Kopka & P.W.Daly, A Guideline to LaTex ,Third edition , Addison- Wesley, London , 1999

*****

pedagogy :

Chalk & talk, PPT, Group discussion, Seminar, Quiz, assignment and video Lecture

Course Code	Course Name	Category	L	T	P	Credit
Elective paper 5	FUZZY SETS AND THEIR APPLICATIONS	Elective	86	4	-	5

Objectives:

- **To introduce the concept of fuzzy theory and study its application in real problems**
- **To study the uncertainty environment through the fuzzy sets that incorporates imprecision and subjectivity into the model formulation and solution process.**
- **To understand the fuzzy relations and fuzzy arithmetic.**
- **To explain the concept of operations on fuzzy sets.**

Course Outcomes: At the end of the course, students should:

CO1: Be able to distinguish between the crisp set and fuzzy set concepts through the learned

CO2: Differences between the crisp set characteristic function and the fuzzy set membership function.

CO3: Be able to draw a parallelism between crisp set operations and fuzzy set operations through the use of characteristic and membership functions respectively.

CO4: Become aware of the use of fuzzy inference systems in the design of intelligent

CO	CO Statement	Knowledge

Number		Level
CO1	Demonstrate the basic concepts of fuzzy sets and membership functions , Know various AI search algorithms	K2
CO2	Ability to find examples for crisp equivalence relation.	K3
CO3	Applying the concept in Fuzzy Morphisms.	K4
CO4	Understand the basics of sampling distribution theory	K5

Mapping with Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	S	S
CO2	S	S	S	M	S
CO3	S	S	S	S	S
CO4	S	S	M	S	S

S- Strong; M-Medium; L-Low

Elective paper 5 FUZZY SETS AND THEIR APPLICATIONS Hours/5Credits

Unit I:From Classical Sets To Fuzzy Sets, Fuzzy Sets Verses Crisp Sets Fuzzy sets: Basic types – Fuzzy sets: Basic Concepts –Additional Properties of α – cuts-Extension Principle for fuzzy sets **.**

Unit II: Operations On Fuzzy Sets Types of operations– Fuzzy complements- Fuzzy Intersections: t-Norms – Fuzzy Unions: t-Conorms - Combinations of Operations**.**

Unit III: Fuzzy Arithmetic Fuzzy numbers - Linguistic variables -Arithmetic operations on intervals –Arithmetic operations on Fuzzy numbers**.**

Unit IV: Fuzzy Relations Binary Fuzzy Relations – Binary Relations on a Single Set – Fuzzy Equivalence Relations – Fuzzy Compatibility Relations –Fuzzy Ordering Relations – Fuzzy Morphisms.

Unit V: Fuzzy Decision Making Individual decision making – Multiperson Decision Making-Ranking methods – Fuzzy Linear programming.

Text Books:

George J. Klir and Bo Yuan, Fuzzy sets and Fuzzy Logic Theory and Applications, Prentice Hall of India, (2005).

Unit I Chapter 1 Sections 1.3, 1.4, Chapter :2 Sections 2.1 and 2.3
Unit II Chapter 3 Sections 3.1, 3.2, 3.3, 3.4, 3.5.
Unit III Chapter 4 Sections 4.1,4.2, 4.3, 4.4.
Unit IV Chapter 5 Sections 5.3 ,5.4, 5.5, 5.6, 5.7, 5.8.
Unit V Chapter 15 Sections 15.2,15.3, 15.6, 15.7

Reference Books:

1. H.J. Zimmermann, Fuzzy Set Theory and its Applications, Allied Publishers Limited (1991).
2. M. Ganesh, Introduction to Fuzzy sets and Fuzzy logic, Prentice Hall of India, New Delhi (2006).

*****

pedagogy :

Chalk & talk, PPT, Group discussion, Seminar, Quiz, assignment and video Lecture

Course Code	Course Name	Category	L	T	P	Credit
Elective paper 6	NEURAL NETWORKS	Elective	86	4	-	5

Objectives:

- **To introduce the main fundamental principles and techniques of neural network systems and investigate the principal neural network models and applications.**
- **To provide the deep knowledge on Dynamic Neural units.**
- **To study the concepts of Continuous-time dynamic neural networks.**

Specific outcome of learning: The learner will acquire in – depth knowledge of Neural Network-Applications of neural network Nonlinear models and dynamics behavior of DNN Hopfield dynamic neural network Conditions for equilibrium points in DNN

Course Outcomes:Students will be able to:

CO1: Understand the differences between networks for supervised and unsupervised learning.

CO2: Design single and multi-layer feed-forward neural networks.

CO3: Develop and train radial-basis function networks.

CO4: Program linear and nonlinear models for data mining.CO5: Analyze the performance of neural networks

CO Number	CO Statement	Knowledge Level
CO1	Demonstrate the basic concepts neural networks-Functioning of artificial neural network-Neuron modelling.	K2
CO2	Apply the concepts in finding Models and circuits of isolated DNUs	K3
CO3	Identify the type Dynamic temporal behaviour of DNN	K4
CO4	Understand the basics Hopfield dynamic neural network (DNN) and its implementation	K5

Mapping with Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	S	S
CO2	S	S	S	M	S
CO3	S	S	S	S	S
CO4	S	S	M	S	S

S- Strong; M-Medium; L-Low

Elective paper 6 NEURAL NETWORKS 6 Hours/5 Credits

Unit I: Architectures: Introduction to Neural Network-Applications of neural network-Biological neural networks-Artificial neural networks-Functioning of artificial neural network-Neuron modelling.

Unit II: Dynamic Neural Units (DNUs): Nonlinear models and dynamics-Models of dynamic neural units-Models and circuits of isolated DNUs-Neuron with excitatory and inhibitory dynamics.

Unit III: Neuron with multiple nonlinear feedback-Dynamic temporal behaviour of DNN-Nonlinear analysis for DNUs.

Unit IV: Continuous-time dynamic neural networks: Dynamic neural network structures: An introduction-Hopfield dynamic neural network (DNN) and its implementation-Hopfield dynamic neural networks (DNNs) as Gradient-like systems.

Unit V: Modifications of Hopfield dynamic neural networks-Other DNN models-Conditions for equilibrium points in DNN.

Text Books:

1.A. AntoSpiritusKingsly, **Neural network and fuzzy logic control**, Anuradha publications, Chennai, 2009.
2.Madan M. Gupta, Liang Jin&Noriyasu Homma, **Static and Dynamic neural networks**, A

John Wiley and sons, INC., Publication, 2003.

Unit 1: Chapters: 1.1—1.6.2 –Text book 1
Unit 2:Chapters: 8.1—8.3—Text book 2
Unit3: Chapters: 8.4—8.6—Text book 2
Unit 4: Chapters: 9.1—9.3—Text book 2
Unit 5: Chapters: 9.4—9.6—Text book 2

Reference Books:

1.JaceK M. Zurada, Introduction to Artificial Neural Systems, Jaico Publishing House, Chennai, 2006.
2.Kevin L. Priddy& Paul E. Keller, Artificial Neural Networks, PHI Learning Private Limited, New Delhi, 2009.
3.Elaine Rich &Kevin Knight, Artificial Intelligence, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2005.
4.S. Rajasekaran& G. A. VijayalakshmiPai, Neural Networks, Fuzzy Logic and Genetic Algorithms synthesis and applications, PHI Learning Private Limited, New Delhi, 2008.

*****

pedagogy :

Chalk & talk, PPT, Group discussion, Seminar, Quiz, assignment and video Lecture

Course Code	Course Name	Category	L	T	P	Credit
Elective Paper 7	STOCHASTIC PROCESS	Elective	86	4	-	5

Objectives:

- **To give a depth knowledge about Markov chain and Process.**
- **To understanding the stochastic models for much real life probabilistic situations and expected results.**
- **To learn the well known models like birth – death and queueing to reorient the knowledge of stochastic analysis.**
- **The learner understands in depth knowledge about ergording, renewal theory and its application in discrete and continuous process.**

Course Outcomes: Upon the successful completion of the course, students will be able to

CO1: The student has basic knowledge about stochastic processes in the time domain.

CO2: The student has acquired more detailed knowledge about Markov processes with a discrete state state space, including Markov chains, Poisson processes and birth and death presses.

CO3: The student also knows about queuing systems and Brownian motion, in addition to mastering the fundamental principles of simulation of stochastic processes and the
construction of Markov chain Monte Carlo (MCMC) algorithms.
CO4: The student is able to formulate simple stochastic process models in the time domain
and provide qualitative and quantitative analyses of such models.

CO Number	CO Statement	Knowledge Level
CO1	**Demonstrate the basic concepts of Stochastic process, Markov chains**	K2
CO2	**Apply the concepts** in Birth and Death Distribution Process	K3
CO3	**Identify the type of the Differential Equations for A Wiener Process -Kolmogorov Equation**	K4
CO4	**Understand the basics of sampling distribution theory**	K5

Mapping with Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	S	S
CO2	S	S	S	M	S
CO3	S	S	S	S	S
CO4	S	S	M	S	S

S- Strong; M-Medium; L-Low

Elective Paper 7 STOCHASTIC PROCESS 6 Hours/5 Credits

Unit I: Basic Definitions: Stochastic Processes: An Introduction - Markov Chains : Definition and Examples - Higher Transition Probabilities - Generalization of Independent Beronoulli Trials : Sequence of Chain – Dependent Trails - Classification of States and Chains – Determination of Higher Transition Probabilities - Stability of A Markov System – Graph Theoretic Approach.

Unit II: Sequence of Chains: Poisson Process -Poisson Process and Related Distributions – Generalizations of Poisson Process - Birth and Death Process

Unit III: Classification of States: Introduction -Brownian Motion – Wiener Process – Differential Equations for A Wiener Process -Kolmogorov Equation – First Passage Time Distribution for wiener Process – Ornstein-Uhlenbeck Process.

Unit IV: Birth and Death Distribution Process: Renewal Process - Renewal Processes in Continuous Time – Renewal Equation - Stopping Time : Wald's Equation - Renewal Theorems

Unit V: Renewal Theorems: Delayed and Equilibrium Renewal Process –Residual and Excess Lifetimes.

Text Books:
J.Medhi "Stochastic process", Second edition- New Age International Publishers.

UnitI : Chapter 1: 1.5; Chapter 2: 2.1 to 2.7
UnitII : Chapter 3 : 3.1 to 3.4
Unit III: Chapter 4: 4.1 to 4.6
Unit IV: Chapter 6: 6.1 to 6.5
Unit V: Chapter 6: 6.6 to 6.11

Reference Books:
1.Samuel Karlin and Howard M. Taylor, "A First Course in stochastic process", second edition, academic Press. 1975
2.Samuel Karlin and Howard M. Taylor, "A Second course in stochastic process", Academic Press, 1981.
3.Narayan Bhat, U, "Elements of Applied Stochastic Processes", Second Edition John Wiley & Sons, New York.
4.Feller, "An Tntroduction to Probability theory and its applications", Volume 1. Third edition, John Wiley & Sons, New York.

*****

pedagogy :

Chalk & talk, PPT, Group discussion, Seminar, Quiz, assignment and video Lecture

Course Code	Course Name	Category	L	T	P	Credit
Elective paper 8	FLUID DYNAMICS	Elective	86	4	-	5

Objectives:

- **It is a subject of almost all fields of engineering, astrophysics, biomedicine, and metrology. Basic concepts of fluid dynamics aredelt with in this paper.**
- **To understand the concepts of irrotational motion*, two dimensional motion and real fluids.***
- ***To provide clear knowledge about fluid dynamics and apply this concepts on real time problems.***
- ***To study the concepts of the laminar boundary layer.***

Course Outcomes:

CO1: Solve hydrostatic problems.

CO2: Describe the motion of fluids.

CO3: Identify derivation of basic equations of fluid mechanics and apply

CO4: Make dimensional analysis and similitude

CO Number	CO Statement	Knowledge Level
CO1	Understand the fundamental knowledge of fluids and its properties	K2
CO2	Describe the concepts and equations of fluid dynamics.	K3
CO3	Apply thermodynamic control volume concepts in fluid dynamics for applications that include momentum, mass and energy balances	K4
CO4	Analyze the approximate solutions of the Navier-Stokes equation	K5

Mapping with Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	S	S
CO2	S	S	S	M	S
CO3	S	S	S	S	S
CO4	S	S	M	S	M

S- Strong; M-Medium; L-Low

Elective paper 8 FLUID DYNAMICS 6 Hours/ 5 Credits

Unit I: Eulerian method: Flow along a stream tube- General equation of motion: Introduction – the equation of motion of an inviscid fluid – Irrotational motion – Boundary condition – uniqueness – Euler momentum theorem.

Unit II: Two Dimensional Motion: Introduction –two dimensional functions – basic singularities- conformal transformation – The Aerofoil .

Unit III: Irrotational Motion in three dimensions : Introduction – Laplace's equation .

Unit IV: Dynamics of real fluids: Introduction – the equations of Motion for Viscous flow- Some exact solutions of the Navier – Stokes equation – very slow motion.

Unit V: The Laminar boundary Layer in incompressible flow: Introduction –The boundary layer equations – Analytic Solutions of the boundary layer equations.

Text Book:

N.Curle and H.J. Davies, Modern Fluid Dynamics, Volume 1, Incompressible Flow, D.VanNostrand Company Ltd, London, 1968.

Unit I: Chapter 1: 1.2.1 and Chapter 2: 2.1 to 2.6

Unit II: Chapter 3: 3.1 to 3.3 , 3.6 , 3.7

Unit III: Chapter 4: 4.1 – 4.2

Unit IV: Chapter 5:5.1 – 5.4

Unit V: Chapter 6: 6.1 , 6.2 (6.2.1, 6.2.3, 6.2.4, 6.2.5) and 6.3

Reference Books:

1. F.Chorlton, "Text book of Fluid Dynamics" , CBS Publishers and distributors, New Delhi-32,1998.
2. M.D.Raisinghawia, " Fluid Dynamics",S.Chand and Company Ltd,

   New Delhi - 55, 1995.
3. S.W. Yuan, Foundations of Fluid Mechanics, by Prentice – Hall of India, New Delgi, 1988.
4. G.K.Batchelor, An Introduction to Fluid Dynamics, Cambridge University Press, 2000.
5. R.K. Bansal, An Introduction to Fluid Dynamics, Firewall Media, 2005
6. D.E. Rutherford, Fluid Dynamics, Oliver and Boyd, 1959.

****

pedagogy :

Chalk & talk, PPT, Group discussion, Seminar, Quiz, assignment and video Lecture

Course Code	Course Name	Category	L	T	P	Credit

Elective paper 9	**NON LINEAR DIFFERENTIAL EQUATIONS**	**Elective**	**86**	**4**	**-**	**5**

Objectives:

- **To study Non-linear Differential equation and its properties.**
- **To study oscillation and stability properties of the solutions.**
- **To provide clear knowledge about perturbation methods.**
- **To understand the concepts of linear systems and stability.**

Course Outcomes: Upon the successful completion of the course, students will be able to

CO1: After completed course, the students are expected to be able to.

CO2: Give account for existence and uniqueness of the solutions of ordinary differential equations solutions.

CO3: Make use of the phase plane to analyse two-dimensional systems with emphasis on equilibrium, existence of limit cycles and linearisation.

CO4: Summarise theorems that related to the existence of periodical solutions, and apply them to simple systems.

CO5: Explain important terms in asymptotic theory, such as, order symbols, asymptotic sequences and asymptotic series, and give account for truncation and convergence of asymptotic series.

CO Number	CO Statement	Knowledge Level
CO1	Demonstrate the basic concepts linear approximation at equilibrium points	K2
CO2	Apply the concepts amplitude Perturbation for the pendulum equation	K3
CO3	Identify the application of Floquet Theory	K4
CO4	Understand the basics Stability and Poincare stability	K5
CO5	Emphasis on estimating the Perturbation Method and Fourier series.	K6

Mapping with Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	S	S
CO2	S	S	S	M	S
CO3	S	S	S	S	S

CO4	**S**	**S**	**M**	**S**	**S**
CO5	**S**	**S**	**S**	**S**	**M**

S- Strong; M-Medium; L-Low

Elective paper 9 NON LINEAR DIFFERENTIAL EQUATIONS 6 Hours/5 Credits

Unit I First order systems in two variables and linearization: The general phase plane-some population models – Linear approximation at equilibrium points – Linear systems in matrix form.

Unit II Averaging Methods: An energy balance method for limit cycles – Amplitude and frequency estimates – slowly varying amplitudes – nearly periodic solutions - periodic solutions: harmony balance – Equivalent linear equation by harmonic balance – Accuracy of a period estimate.

Unit III Perturbation Methods: Outline of the direct method – Forced Oscillations far from resonance - Forced Oscillations near resonance with Weak excitation – Amplitude equation for undamped pendulum – Amplitude Perturbation for the pendulum equation – Lindstedt's Method – Forced oscillation of a self – excited equation – The Perturbation Method and Fourier series.

Unit IV Linear Systems: Time Varying Systems – Constant coefficient System – Periodic Coefficients – Floquet Theory – Wronskian.

Unit V Stability: Poincare stability – solutions, paths and norms – Liapunov stability Stability of linear systems – Comparison theorem for the zero solutions of nearly – linear systems.

Text Book

Nonlinear Ordinary Differential Equations , D.W.Jordan, & P.Smith, Clarendon Press, Oxford, 1977.

References

1. Differential Equations by G.F.Simmons, Tata McGraw Hill, NewDelhi (1979).
2. Ordinary Differential Equations and Stability Theory By D.A.Sanchez, Freeman (1968).
3. Notes on Nonlinear Systems by J.K.Aggarwal, Van Nostrand, 1972.

*****

pedagogy :

Chalk & talk, PPT, Group discussion, Seminar, Quiz, assignment and video Lecture

Course Code	Course Name	Category	L	T	P	Credit
Elective paper 10	FINANCIAL MATHEMATICS	Elective	86	4	-	5

Objectives:

- **To study financial mathematics through various models.**
- **To study the various aspects of financial mathematics.**
- **To provide the deep knowledge on Brownian motion and stochastic calculus.**
- Use financial mathematics to solve the real time problems.

Course Outcomes: Upon the successful completion of the course, students will be able to

Course Outcomes:

CO1: On successful completion of this course students will be able to:

CO2: Demonstrate understanding of basic concepts in linear algebra, relating to linear equations, matrices, and optimization.

CO3: Demonstrate understanding of concepts relating to functions and annuities.

CO4: Employ methods related to these concepts in a variety of financial applications.

CO5: Apply logical thinking to problem solving in context.

CO Number	CO Statement	Knowledge Level

CO1	**Demonstrate the basic concepts of Single period models and Neutral Probability Measure**	**K2**
CO2	**Apply the concepts binomial trees and discrete parameter martingales**	**K3**
CO3	**Identify the type Stochastic Integration**	**K4**
CO4	**Understand the basics of martingales in Continuous time**	**K5**
CO5	**Emphasis on estimating block-scholes model**	**K6**

Mapping with Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	**S**	**S**	**S**	**S**	**S**
CO2	**S**	**M**	**S**	**M**	**S**
CO3	**S**	**S**	**S**	**S**	**S**
CO4	**S**	**S**	**M**	**S**	**M**
CO5	**S**	**S**	**M**	**S**	**M**

S- Strong; M-Medium; L-Low

Elective paper 10 FINANCIAL MATHEMATICS 6Hours/ 5 Credits

Unit I Single period models: definitions from finance - pricing a forward - one-step Binary Model - a ternary Model - Characterization of no arbitrage - Risk-Neutral Probability Measure.

Unit II Binomial trees and discrete parameter martingales: Multi-period Binary model - American Options - Discrete parameter martingales and Markov processes - Martingale Theorems - Binomial Representation Theorem - Overturn to Continuous models.

Unit III Brownian motion: Definition of the process - Levy's Construction of Brownian Motion - The Reflection Principle and Scaling - Martingales in Continuous time.

Unit IV Stochastic calculus: Non-differentiability of Stock prices - Stochastic Integration - Ito's formula - Integration by parts and Stochastic Fubini Theorem - Girsanov Theorem - Brownian Martingale Representation Theorem – Geometric Brownian Motion - The Feynman - Kac Representation.

Unit V Block-scholes model: Basic Block-Scholes Model - Block-Scholes price and hedge for European Options - Foreign Exchange - Dividends - Bonds - Market price of risk.

Text Book

Alison Etheridge, **A Course in Financial Calculus**, Cambridge University Press, Cambridge, 2002.

References

1. Martin Boxter and Andrew Rennie, Financial Calculus: An Introduction to Derivatives Pricing, Cambridge University Press, Cambridge, 1996.

2. Damien Lamberton and Bernard Lapeyre, (Translated by Nicolas Rabeau and Farancois Mantion), Introduction to Stochastic Calculus Applied to Finance, Chapman and Hall, 1996.
3. Marek Musiela and Marek Rutkowski, Martingale Methods in Financial Modeling, Springer Verlag, New York, 1988.
4. Robert J.Elliott and P.Ekkehard Kopp, Mathematics of Financial Markets, Springer Verlag, New York, 2001 (3rd Printing)

*****

pedagogy :

Chalk & talk, PPT, Group discussion, Seminar, Quiz, assignment and video Lecture

Course Code	Course Name	Category	L	T	P	Credit
Elective paper 11	CONTROL THEORY	Elective	86	4	-	5

Objectives:

- **To introduce basic theories and methodologies required for analyzing and designing advanced control systems.**
- **Specific outcome of learning: The learner will acquire skills to solve observability problems of linear and nonlinear systems.**
- **Proficient in solving linear and nonlinear control system Proficient in stability analysis of linear and nonlinear systems Proficient in stabilization of control systems Proficient in optimal control problems. To able to solve problems on control theory**

Course Outcomes: Upon the successful completion of the course, students will be able to

CO1: Be able to understand Reconstruction Kernal, streaming Function

CO2: Able to analyze the stability of linear systems

CO3: Problem solving skillsare developed in linear time invariant systems

CO Number	CO Statement	Knowledge Level

CO1	**Describe the basic concepts and properties of differential equations, fundamental concepts of control system**	**K2**
CO2	**Understand about concept of observable and controllable system.**	**K3**
CO3	**Ability to analyze and design a new control system.**	**K4**

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	**S**	**S**	**S**	**S**	**S**
CO2	**S**	**S**	**S**	**M**	**S**
CO3	**S**	**S**	**S**	**S**	**S**

S- Strong; M-Medium; L-Low

Elective paper 11 CONTROL THEORY 6 Hours/5 Credits

.**Unit I**: Observability: Linear systems – Observability Grammian – Constant coefficient systems – Reconstruction kernel – Nonlinear Systems

Unit II: Controllability: Linear systems – Controllability Grammian – Adjoint systems Constant coefficient systems – Steering function – Nonlinear systems

Unit III: Stability: Stability – Uniform stability – Asymptotic stability of linear Systems - Linear time varying systems – Perturbed linear systems – Nonlinear systems

Unit IV: Stabilizability: Stabilization via linear feedback control – Bass method – Controllable subspace –Stabilization with restricted feedback

Unit V: Optimal Control: Linear time varying systems with quadratic performance criteria – Matrix Riccati equation – Linear time invariant systems – Nonlinear Systems

Text Book:

K. Balachandran & J. P. Dauer, Elements of Control Theory, Narosa, New Delhi, 1999.

References Books:

1.Linear Differential Equations and Control by R.Conti, Academic Press, London, 1976.

2.Functional Analysis and Modern Applied Mathematics by R.F.Curtain and A.J.Pritchard,

Academic Press, New York, 1977.
3.Controllability of Dynamical Systems by J.Klamka, Kluwer Academic Publisher, Dordrecht, 1991

*****

pedagogy :

Chalk & talk, PPT, Group discussion, Seminar, Quiz, assignment and video Lecture

Course Code	Course Name	Category	L	T	P	Credit
Elective paper 12	FRACTAL ANALYSIS	Elective	86	4	-	5

Objectives:

- **To introduce the basic mathematical techniques of fractal geometry for diverse applications.**
- **.To understand the concepts of the space of fractals and fractal dimensions**
- **To provide the clear knowledge about fractals and measures.**

Course Outcomes: Upon the successful completion of the course, students will be able to

CO1: Understand the contraction mappings on the space of Fractals

CO2: Able to analyze fractal dimensions

CO3: Understand The Structured Walk Technique and the Divider Dimension

CO4: The learner will able to understand the basic concepts of fractals and measure recognize the space of fractals and fractal dimension

CO5: find the Hausdorff, box-counting and other dimensions understand the self – similar sets properties of fractals recognize the concepts fractal interpolation.

CO Number	CO Statement	Knowledge Level
CO1	Demonstrate the basic concepts fractals and measures. Fractal Interpolation Functions and Graphs of Functions	K2
CO2	Apply the Experimental Determination of the Fractal Dimension.	K3

CO3	**Identify the Self-Similar Sets, Similarity Dimensions and Divider Dimensions**	**K4**
CO4	**Understand the basics t**he Sierpinski Gasket and Carpet	**K5**
CO5	**Emphasis Collage Theorem for IFS**	**K6**

Mapping with Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	**S**	**S**	**S**	**S**	**S**
CO2	**S**	**S**	**S**	**M**	**S**
CO3	**S**	**S**	**S**	**S**	**S**
CO4	**S**	**S**	**M**	**S**	**S**
CO5	**S**	**S**	**S**	**S**	**M**

S- Strong; M-Medium; L-Low

Elective paper 12 FRACTAL ANALYSIS 6Hours/5 Credits

.

Unit I: Fractals and Measures: Introduction to Fractals – History of Fractals –Fractal Examples: The Triadic Cantor Set -The Sierpinski Gasket- A space of Strings-The Koch Curve -Heighway's Dragon -Measures and Mass Distributions: Examples of Measures - Notes on Probability Theory -Topological Dimension.

Unit II: The Space of Fractals and Fractal Dimension : The Contraction Mapping Theorem-The HausdorffMetric – The Metric Space (H(X), *h*): The Place Where Fractals Live – Iterated Functions Systems – Contraction Mappings on the Space of Fractals – Fractal Dimension – The Box-Counting Theorem – The Theoretical Determination of the Fractal Dimension – The Experimental Determination of the Fractal Dimension.

Unit III: Hausdorff, Box-Counting and Other Dimensions : Hausdorff Measure – Hausdorff Dimension – Calculation of Hausdorff Dimension-Simple Examples – Equivalent Definition of Hausdorff Dimension – Finer Definitions of Dimension – Box-Counting Dimensions – Properties and Problems of Box-Counting Dimension – Modified Box-Counting Dimensions – Packing Measures and Dimensions – Some Other Definitions of Dimension – Techniques for

Calculating Dimensions: Basic Methods – Subsets of Finite Measure – Potential Theoretic Methods – Fourier Transform Methods.

Unit IV: Self-Similar Sets, Similarity Dimensions and Divider Dimensions: Ratio Lists – Iterated Function Schemes – Dimension of Self -Similar Sets – Some Variations – Self-affine Sets – Applications to Encoding Images – Determination of Similarity Dimensions: The Cantor Set – The Koch Curve – The Quadratic Koch Curve – The Koch Island – The Sierpinski Gasket and Carpet – The Menger Sponge – The Structured Walk Technique and the Divider Dimension.

Unit V: Fractal Interpolation Functions and Graphs of Functions : Interpolation Functions- Fractal Interpolation Functions – The Fractal Dimension of Fractal Interpolation Functions – Collage Theorem for IFS – Dimensions of Graphs – The Weierstrass Function- Self-affine Curves – Autocorrelation of Fractal Functions.

Text Books:

1.Kenneth J. Falconer, **Fractal Geometry: Mathematical Foundations and Applications**, John Wiley and Sons, 2003.
2. Michael F. Barnsley, **Fractals Everywhere**, Academic Press Professional, 1988.

Reference Books:

1.G. A. Edgar, Measure, Topology and Fractal Geometry, Springer – New York, 2008.
2.Kenneth J. Falconer, The Geometry of Fractals Sets, Cambridge University Press, Cambridge, 1985.
3.Paul S. Addison, Fractals and Chaos: An Illustrated Course, Overseas Press, 2005.

*****

pedagogy :

Chalk & talk, PPT, Group discussion, Seminar, Quiz, assignment and video Lecture

Course Code	Course Name	Category	L	T	P	Credit
Elective paper 13	**TENSOR ANALYSIS AND SPECIAL THEORY OF RELATIVITY**	**Elective**	**86**	**4**	**-**	**5**

Objectives:

- **To introduce the notion of Tensor and study its properties.**
- **To study the theory of relativity.**
- **To understand the concepts of invariance, metric tensor and Einstein tensor.**
- **To study specific theory of relativity and relativistic dynamics.**

Course Outcomes: Upon the successful completion of the course, students will be able to

CO1: Use tensor notation in relativity theory.

CO2: Apply the concepts of length contraction and time dilation as well as use Lorentz transformations.

CO3: Solve simple kinematical problems.

CO4: Analyze Maxwell's equations and use their relativistic invariance

CO Number	CO Statement	Knowledge Level
CO1	Understand concept of tensor variables and difference from scalar or vector variables.	K2
CO2	Derive base vectors, metric tensors and strain tensors in an arbitrary coordinate system..	K3
CO3	Investigate the Christoffel symbols which provide a concrete representation of the connection of (pseudo-)Riemannian geometry in terms of coordinates on the manifold	K4
CO4	Apply Riemannan-Christoffel tensor to problems of differential geometry, electrodynamics and relativity	K5

Mapping with Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	S	S
CO2	S	S	S	M	S
CO3	S	S	S	S	S
CO4	S	S	M	S	S

S- Strong; M-Medium; L-Low

Elective paper 13 TENSOR ANALYSIS AND SPECIAL THEORY OF RELATIVITY
6 Hours/ 5 Credits

Unit I: Invariance - Transformations of coordinates and its properties - Transformation by invariance - Transformation by covariance and contra variance - Covariance and contra variance - Tensor and Tensor character of their laws - Algebras of tensors - Quotient tensors - Symmetric and skew symmetric tensors – Relative tensors.

Unit II: Metric Tensor - The fundamental and associated tensors - Christoffel's symbols - Transformations of Chrisffel's symbols- Covariant Differentiation of Tensors - Formulas for covariant Differentiation- Ricci Theorem - Riemann -Christoffel Tensor and their properties.

Unit III: Einstein Tensor- Riemannian and Euclidean Spaces (Existence Theorem)-The e-systems and the generalized Kronecker deltas - Application of the e-systems.

Unit IV: Special Theory of Relativity: Galilean Transformation - Maxwell's equations - The ether Theory – The Principle of Relativity Relativistic Kinamatics : Lorentz Transformation equations - Events and simultaneity - Example Einstein Train - Time dilation - Longitudinal Contraction -Invariant Interval - Proper time and Proper distance – World line - Example - twin paradox - addition of velocities - Relativistic Doppler effect.

Unit V: Relativistic Dynamics : Momentum – energy – Momentum-energy four vector – Force – Conservation of Energy – Mass and energy – Example – inelastic collision – Principle of equivalence – Lagrangian and Hamiltonian formulations .

Accelerated Systems : Rocket with constant acceleration – example – Rocket with constant thrust

Text Books:

1. I.S. Sokolnikoff, **Tensor Analysis**, John Wiley and Sons, New York, 1964
2. D. Greenwood, **Classical Dynamics**, Prentice Hall of India, New Delhi, 1985

Unit I Chapter 2 : Sections 18 to 28 of [1]
Unit II Chapter 2 : Sections 29 to 37 of [1]
Unit III Chapter 2 : Section 38 to 41 of [1]
Unit IV Chapter 7 : Sections 7.1 and 7.2 of [2]
Unit V Chapter 7 : Sections 7.3 and 7.4 of [2]

Reference Books:

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

*****

pedagogy :

Chalk & talk, PPT, Group discussion, Seminar, Quiz, assignment and video Lecture

Course Code	Course Name	Category	L	T	P	Credit
Elective paper 14	MATHEMATICAL BIOLOGY	Elective	86	4	-	5

Objectives:

- ***To introduce the concept of Mathematical biology and study its applications.***
- ***To study some basic concepts of mathematical biology.***
- ***To provide a deep knowledge about models.***
- **To understand the concepts of Biochemical kinetics.**

Course Outcomes:The student should be able to

CO1: Formulate and solve mathematical models of evolution in terms of optimisation and game theory problems;

CO2: Use techniques from stochastic processes to describe population genetics;

CO3: Use techniques from partial differential equations to describe spread of genes, disease and other biological material;

CO4: Explain how these techniques are applied in scientific studies and applied in ecology and epidemiology.

CO Number	CO Statement	Knowledge Level
CO1	Understand concept of Single Species Population Dynamics Continuous time models	K2
CO2	Identify infectious Diseases Simple epidemic and SIS diseases..	K3
CO3	Investigate the Christoffel symbols which provide a concrete representation of the connection of (pseudo-)Riemannian geometry in terms of coordinates on the manifold	K4
CO4	Apply Biochemical Kinetics Simple models for polymer growth dynamics	K5

Mapping with Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	S	S
CO2	S	S	S	M	S
CO3	S	S	S	S	S
CO4	S	S	M	S	S

S- Strong; M-Medium; L-Low

Elective paper 14 MATHEMATICAL BIOLOGY 6 Hours/5Credits

Unit I: Single Species Population Dynamics Continuous time models – Growth models, Logistic model – Evolutionary Aspects – Delay models.

Unit II: Two Species Population Dynamics TheLotka-Volterra Prey-Predator equations – Modelling the predator functional response Competition – Ecosystems modelling.

Unit III: Infectious Diseases Simple epidemic and SIS diseases – SIR Epidemics – SIR Endemics.

Unit IV: Biochemical KineticsTransitions between states at the molecular and populations level – Law of mass action – Enzyme kinetics.

Unit V: Biochemical Kinetics Simple models for polymer growth dynamics.

Text Books:

1.N. Britton, **Essential Mathematical Biology**, Springer Science & Business Media, 2012.
Unit I- Chapter 1: 1.3-1.5,1.7.

Unit II- Chapter 2: 2.3-2.

Unit III- Chapter 3: 3.1-3.4

2..A. Segel and L. Edelstein-Keshet, **A Primer in Mathematical Models in Biology**, SIAM,

Vol. 129, 2013.

Unit IV- Chapter 2: 2.1-2.4

Unit V- Chapter 2: 2.5

Reference Books:

1.J.D. Murray, "Mathematical Biology I: An Introduction", Springer-Verlag, New York, 2002.

2. A. D. Bazykin, "Nonlinear dynamics of interacting populations", World Scientific, 1998.

3.J.N.Kapur, "Mathematical Models in Biology and Medicine", Affiliated East–West, New Delhi, 1985.

*****

pedagogy :

Chalk & talk, PPT, Group discussion, Seminar, Quiz, assignment and video Lecture

Employability/Entrepreneurship/ Skill Development

Name of the Course	Course Code	Name of the Programme	Activities with direct bearing on Employability/ Entrepreneurship/ Skill development
Differential Equations	PMTT13	M.Sc Mathematics	Employability Skill
Graph Theory	PMTT14	M.Sc Mathematics	Employability Skill
Topology	PMTT23	M.Sc Mathematics	Employability Skill
Optimization Techniques	PMTT24	M.Sc Mathematics	Employability Skill/ Entrepreneurship
Automata Theory	PMTE11/22/33(Elective)	M.Sc Mathematics	Employability Skill/Soft Skill
Financial Mathematics	PMTE11/22/33(Elective)	M.Sc Mathematics	Employability Skill/ Entrepreneurship
MatLab and LaTeX	PMTE11/22/33(Elective)	M.Sc Mathematics	Entrepreneurship/ Employability/ Skill
Measure Theory	PMTT32	M.Sc Mathematics	Employability/Entrepreneur
Classical Dynamics	PMTT33	M.Sc Mathematics	Employability
Calculous of Variations and Integral Equations	PMTT34	M.Sc. Mathematics	Employability
Probability Theory and Statics	PMTE11/22/33(Elective)	M.Sc. Mathematics	Employability/ Entrepreneur
Fuzzy Sets and their Applications	PMTE11/22/33(Elective)	M.Sc. Mathematics	Employability/ Entrepreneur
Stochastic Processes	PMTE11/22/33(Elective)	M.Sc. Mathematics	Employability/ Entrepreneur
Non linear Differential Equations	PMTE11/22/33(Elective)	M.Sc. Mathematics	Employability/ Entrepreneur
Financial Mathematics	PMTE11/22/33(Elective)	M.Sc. Mathematics	Employability
Mathematical Biology	PMTE11/22/33(Elective)	M.Sc. Mathematics	Employability
Algebric Number Theory	PMTE11/22/33(Elective)	M.Sc. Mathematics	Employability
Neural Network	PMTE11/22/33(Elective)	M.Sc. Mathematics	Soft Skill
Control Theory	PMTE11/22/33(Elective)	M.Sc. Mathematics	Employability/ Entrepreneur/ Skill