MASTER OF SCIENCE
MATHEMATICS

SYLLABUS: 2018-19
(Outcome Based Education)

Dr. N.G.P. ARTS AND SCIENCE COLLEGE

(An Autonomous Institution, Affiliated to Bharathiar University, Coimbatore)
Approved by Government of Tamil Nadu and Accredited by NAAC with 'A' Grade (2nd Cycle)
Dr. N.G.P.- Kalapatti Road, Coimbatore-641048, Tamil Nadu, India
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MASTER OF SCIENCE - MATHEMATICS
REGULATIONS

ELIGIBILITY

A candidate who has passed the Degree Examination in B.Sc. (Mathematics) or B.Sc (Mathematics with Computer Applications) of Bharathiar University and as per the norms set by the Government of Tamil Nadu or an Examination accepted as equivalent thereto by the Academic Council, subject to such conditions as may be prescribed thereto are permitted to appear and qualify for the **Master of Science-Mathematics Degree Examination** of this College after a course of study of two academic years.

PROGRAMME EDUCATIONAL OBJECTIVES:

- The graduates will engage in life-long learning and professional development through self-study, continuing education or professional and doctoral level studies.
- Can be able to teach Mathematics at all level of education
- Career opportunities in government and private sectors
- Can face the competitive examinations like, UPSC, TNPSC, GATE, SET/NET, etc

SCHEME OF EXAMINATION

Course Code	Course	Hrs of Instruction	Exam Duration (Hrs)	Max Marks			Credit Points
				CA	CE	Total	
First Semester							
17PMT13A	CORE - I: Algebra	6	3	25	75	100	4
17PMT13B	CORE - II: Real Analysis	6	3	25	75	100	4
17PMT13C	CORE - III: Ordinary Differential Equations	6	3	25	75	100	4
17PMT13D	CORE - IV: Numerical Analysis	6	3	25	75	100	4
	ELECTIVE - I	6	3	25	75	100	4
		30				**500**	**20**
Second Semester							
17PMT23A	CORE - V :Complex Analysis	5	3	25	75	100	4
17PMT23B	CORE - VI: Partial Differential Equations	6	3	25	75	100	4
17PMT23C	CORE –VII: Topology	6	3	25	75	100	4
17PMT23D	CORE - VIII: Mathematical Softwares	4	3	25	75	100	4
17PMT23P	CORE LAB- I: Mathematical Softwares	3	3	20	30	50	2
	ELECTIVE - II	6	3	25	75	100	4
		30				**550**	**22**
Third Semester							
17PMT33A	CORE - IX: Functional Analysis	6	3	25	75	100	4
17PMT33B	CORE - X: Mechanics	6	3	25	75	100	4
17PMT33C	CORE - XI: Mathematical Statistics	6	3	25	75	100	4

20/12/19

BoS Chairman/HoD
Department of Mathematics
Dr. N. G. P. Arts and Science College
Coimbatore – 641 048

Dr.N.G.P.Arts and Science College(Autonomous)

Academic Council
Dr.V. Rajendran
CHAIRMAN
Dr.N.G.P. Arts and Science College

17PMT33D	CORE - XII: Stochastic Differential Equations	6	3	25	75	100	4
	ELECTIVE - III	6	3	25	75	100	4
		30				**500**	**20**
Fourth Semester							
17PMT43A	CORE –XIII: Fluid Dynamics	6	3	25	75	100	4
17PMT43B	CORE - XIV: Mathematical Methods	6	3	25	75	100	4
17PMT43C	CORE - XV: Control Theory	5	3	25	75	100	4
17PMT43D	CORE - XVI: Statistical Software	4	3	25	75	100	4
17PMT43P	CORE LAB -II: Statistical Software	3	3	20	30	50	2
17PMT43V	Project Work		3	60	90	150	6
	ELECTIVE - IV	6	3	25	75	100	4
		30				**700**	**28**
	TOTAL					**2250**	**90**

ELECTIVE – I:

(Student shall select any one of the following Course as Elective - I in First Semester)

S. No	Course Code	Name of the Course
1	17PMT1EA	Fuzzy Sets and Fuzzy Logic
2	17PMT1EB	Object Oriented Programming with C++
3	17PMT1EC	Advanced Operations Research

ELECTIVE – II:

(Student shall select any one of the following Course as Elective - II in Second Semester)

S. No	Course Code	Name of the Course
1.	17PMT2EA	Mathematical Finance
2.	17PMT2EB	Mathematical Biology
3.	17PMT2EC	Actuarial Mathematics

ELECTIVE – III:

(Student shall select any one of the following Course as Elective - III in Third Semester)

S. No	Course Code	Name of the Course
1.	17PMT3EA	Mathematical Modeling
2.	17PMT3EB	Cryptography
3.	17PMT3EC	Neural Networks

ELECTIVE – IV:

(Student shall select any one of the following Course as Elective - IV in Fourth Semester)

S. No	Course Code	Name of the Course
1.	17PMT4EA	Differential Geometry
2.	17PMT4EB	Nonlinear Ordinary Differential Equations
3.	17PMT4EC	Computational Fluid Dynamics

Total Marks and Credit Distribution

Subjects	Total Papers	Marks per Paper	Credits per Paper	Total Marks	Credits	Cumulative Total
Core	16	100	4	1600	64	64
Core	2	50	2	100	04	68
Project	1	150	6	150	06	74
Elective	4	100	4	400	16	90
Total				**2250**	**90**	

Earning extra credits are not mandatory for Programme completion

Extra Credits

Course	Credits
Publication with ISSN/ISBN Journal	**1**
Hindi /Other Foreign language	**1**
Prize winning presentations in Sponsored National/ International Seminar/conference/ Participation in sponsored National or International workshop with a minimum duration of five days	**1**
Passing any one of self study papers	**1**
Representation – Academic/Sports /Social Activities/ Extra Curricular Activities at University/ District/ State/ National/ International level	**1**
Total Extra Credits	**05**

Rules:

The students can earn extra credits only if they complete the above within third semester of the programmer based on the following criteria.

1) Proof of Completion must be submitted in the office of the Controller of Examinations before the commencement of the IV Semester.
2) Publication in a journal with ISSN or ISBN number by a student, co - authored by staff member will be given one credit extra.
3) Student can opt Hindi/ French/ Other foreign Language approved by certified Institutions to earn one credit. The certificate (Hindi) must be

obtained from Dakshina Bharat Hindi Prachar Sabha and He/ she has to enroll and complete within third semester of the programme.

4) Prize winners in Paper Presentation events of sponsored national or international Seminar/conference or participation in workshops sponsored by any government agencies (minimum 5 days) will be given one credit extra.
5) Student can earn one credit, if they clear any one of Self study papers
6) Prize Winners in /Social Activities/Extra Curricular/Co–Curricular Activities or representation in Sports at University/District/State/National/International level can earn one extra credit.

Self study paper offered by the Mathematics Department

S. No.	Course Code	Course Title
1.	**17PMTSS1**	**Industrial Mathematics**
2.	**17PMTSS2**	**Mathematics of Bio Informatics**

PROGRAMME OUTCOMES:

On the successful completion of the programme, the following expected outcomes

PO Number	PO Statement
PO1	Students will have knowledge, understanding and Mathematical thinking of the basic and advanced concepts, techniques from different topics
PO2	They have a fundamental and advanced understanding of at least one Mathematical topic of their choice and able to solve problem related to the topic
PO3	They can be able to communicate clearly in writing and orallying the detailed technical arguments of complex Mathematical concepts
PO4	The students develop problem solving skill and apply them independently to problems in pure and applied Mathematics
PO5	They can develop the knowledge of formulating, analyzing and problem solving in core areas of the Mathematics including Analysis, Algebra and Statistics

17PMT13A	CORE - I : ALGEBRA	SEMESTER - I

PREAMBLE:

- Use results from elementary group theory to solve contemporary problems
- Explain from elementary principles why certain algebraic facts are true
- Use Sylow's theorems to describe the structure of certain finite groups

COURSE OUTCOMES:

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Learn about the Group theory	**K1**
CO2	Application of Sylow theory and the Ring theory	**K3**
CO3	Find the Algebric extensions	**K2**
CO4	Learn about Automorphisms and Isomorphism	**K1**
CO5	Application of Galois theory	**K3**

Mapping with program Outcomes:

COS/POS	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	S	S
CO2	S	M	M	S	S
CO3	S	S	S	M	S
CO4	S	M	M	M	M
CO5	S	M	S	M	S

S-Strong; M- Medium; L-Low.

17PMT13A	CORE - I : ALGEBRA	SEMESTER - I

Total Credits: 4
Hours perWeek: 6

CONTENT

UNIT - I: Direct Products: External Direct Products- Internal Direct Products. **Group Action on a Set:** The Notion of a Group Action- Fixed Sets and Isotropy Subgroups – Orbits. **Application on G-Sets to Counting**: **Sylow Theorems:** p - Groups - The Sylow Theorems.

UNIT - II: Applications of the Sylow Theory: Applications to p - Groups and the Class Equation - Further Applications. **Rings of Polynomials:** Polynomials in an Indeterminate - The Evaluation Homomorphisms. The New Approach. **Factorization of Polynomials over a Field:** The Division Algorithm in $F[x]$ - Irreducible Polynomials – Ideal Structure in $F[x]$ - Uniqueness of Factorization in $F[x]$.

UNIT - III: Introduction to Extension Fields: Extension Fields - Algebraic and Transcendental Elements - Irreducible Polynomial for α over F - Simple Extensions. **Algebraic Extensions:** Finite extensions – The Structure of a Finite Fields.

UNIT - IV: Automorphisms of Fields: Basic Isomorphism of Algebraic Field Theory - Automorphisms and Fixed Fields - The Frobenius

Automorphism. **Isomorphishm Extension Theorem:** The Extension Theorem - Splitting Fields.

UNIT - V: Separable Extensions-Galois Theory: Normal Extensions - The Main Theorem. **Illustrations of Galois Theory:** Symmetric Functions.

TEXT BOOKS:

1. *John B. Fraleigh,* **"A First Course in Abstract Algebra",** Third Edition, 2003, Narosa Publishing House.

Unit – I	:	Chapter 8, 16, 17, 18
Unit – II	:	Chapter 19, 30, 31
Unit – III	:	Chapter 35, 38 (38.1 only), 45 (45.1 only).
Unit – IV	:	Chapter 40, 41 (41.1 only), 42.
Unit - V	:	Chapter 43(except 43.4), 46, 47.

REFERENCES BOOKS:

1. *I.N. Herstein,* **"Topics in Algebra",** Second Edition, 2007, Narosa Publishing House, New Delhi.
2. *M. Artin,* **"Algebra",** 1991, Prentice-Hall of India, New Delhi.

17PMT13B	CORE - II: REAL ANALYSIS	SEMESTER - I

PREAMBLE:

- To give a systematic study of Riemann Stieltjes integral and a brief study of convergence, continuity and Lebesque measure.
- To study the Inverse and Implicit function theorems.

COURSE OUTCOMES:

On the successful completion of the course, the student will be able to

CO Number	CO Statement	Knowledge Level
CO1	Learn the Riemann Stieltjes integral of a bounded function and prove a selection of theorems concerning integration	**K1**
CO2	Understand the concept of convergence and continuity	**K2**
CO3	Know the concept of inverse and implicit theorems	**K3**
CO4	Understand the concept of Lebesque measure	**K4**
CO5	Learn the Lebesque integral	**K5**

Mapping with Program Outcomes:

CO's/POS	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	S	S
CO2	S	S	S	S	L
CO3	S	S	S	L	M
CO4	S	S	S	M	S
CO5	S	L	S	M	S

S-Strong; M-Medium; L-Low

17PMT13B	CORE - II: REAL ANALYSIS	SEMESTER - I

Total Credits: 4
Hours per Week: 6

CONTENT

UNIT - I

The Riemann Stieltjes Integral: Definition and Existence of the Integral – Properties of the integral – Integration and Differentiation – Integration of Vector-valued Function – Rectifiable Curves.

UNIT – II

Sequence and Series of a Function: Uniform Convergence - Uniform Convergence and Continuity – Uniform Convergence and Integration – Uniform Convergence and Differentiation – Equicontinuous Families of Functions – The Stone-Weierstrass Theorem.

UNIT – III

Functions of Several Variables: Linear Transformation – The Contraction Principle – The Inverse Function Theorem – The Implicit Function Theorem.

UNIT – IV

Lebesgue Measure: Introduction - Outer Measure – Measurable sets and Lebesgue Measure – Measurable Functions – Littlewood's Three Principles.

UNIT – V

Lebesgue Integral: The Lebesgue Integral of a Bounded Function over a Set of Finite Measure – The Integral of a Non-negative Function – The General Lebesgue Integral – Convergence in Measure.

TEXT BOOKS:

1. *Walter Rudin,* **"Principles of Mathematical Analysis"**, Third Edition, 1976, McGraw-Hill Book Company, New York.

   Unit – I : Chapter 6

   Unit – II : Chapter 7

   Unit – III : Chapter 9 (Pages 204 to 227)

2. *H.L. Royden,* **"Real Analysis",** Third Edition, 2005, Prentice-Hall of India Private Limited, New Delhi.

   Unit- IV : Chapter 3 (except Section – 4)

   Unit –V : Chapter 4 (Sections 2, 3 & 4 only)

REFERENCE BOOKS:

1. *R.G. Bartle,* **"Introduction to Real Analysis",** Third Edition, 2005, John Wiley and Sons Inc, New York.
2. *Walter Rudin,* "**Real and Complex Analysis",** Third Edition, 1987, McGraw – Hill, New York.

17PMT13C	CORE - III: ORDINARY DIFFERENTIAL EQUATIONS	SEMESTER - I

PREAMBLE:

1. This subject provides the fundamental knowledge in first order and second order ordinary differential equations.
2. Students know about the homogenous and non-homogeneous order ordinary differential equations.

COURSE OUTCOMES:

On the successful completion of the course, student will be able to

CO Number	CO Statement	Knowledge Level
CO 1	Learn Lipschitz condition, Gronwall's Bihari inqualities, Picard's Successive Approximations, Picard's Theorem , comparison theorems, upper lower and oscillatory solutions	**K1**
CO 2	Summarize the Fundamental matrices	**K2**
CO 3	Solving differential equations	**K3**
CO 4	Analyze qualitative properties and power series solutions	**K4**
CO 5	Design of differential equations Models in various fields	**K5**

Mapping with Program Outcomes:

COS/POS	PO1	PO2	PO3	PO4	PO5
CO1	S	M	S	S	S
CO2	S	M	S	S	S
CO3	S	S	S	S	S
CO4	S	S	S	S	S
CO5	S	S	S	S	S

S-Strong; M-Medium; L-Low

17PMT13C	CORE - III: ORDINARY DIFFERENTIAL EQUATIONS	SEMESTER - I

Total Credits: 4
Hours per Week: 6

CONTENT

UNIT - I

Existence and Uniqueness of Solutions: Preliminaries - Picard's successive approximations – Picard's theorem – Some examples. **Existence Theorem and Solutions:** Existence theorem - External Solutions – Upper and lower– Bihari's inequality

UNIT – II

System of Linear Differential Equations: System of first - order Equations – Model for ARMS competition between two nationals – Existence and uniqueness theorem – Fundamental matrix.

UNIT – III

Non - homogeneous linear systems – Linear systems with constant coefficients - linear systems with periodic coefficients – Variation of parameters

UNIT – IV

Solutions in Power Series: Second order linear equations with ordinary points – Legendre equation and Legendre polynomials – Second order equation with regular singular point – Bessel functions.

UNIT – V

Oscillations of Second Order Equations: Introduction – Sturm's comparison theorem – Elementary linear oscillations. Comparison theorem of Hille - Winter – Oscillations of $x'' + a(t)\, x = 0$.

TEXT BOOKS:

1. *S.G. Deo, V. Raghavendra, Rasmita Kar and V. Lakshmikandham,* "**Text book of Ordinary Differential Equations",** Third Edition, 2015, McGraw-Hill Education (India), New Delhi.

Unit – I	:	Chapter 2: Section 2.2 - 2.5 & Chapter 3: Section 3.2 to 3.4, 3.6
Unit – II	:	Chapter 5: Section 5.2 to 5.5
Unit – III	:	Chapter 5: Section 5.6 to 5.9
Unit – IV	:	Chapter 6: Section 6.2 to 6.5
Unit – V	:	Chapter 7: Section 7.1 to 7.5

REFERENCE BOOKS:

1. *W.T. Reid,* "**Ordinary Differential Equations",** 1971, John Wiley & Sons, New York.
2. *E.A. Coddington, and N. Levinson,* "**Theory of Ordinary Differential Equations"**, 1955, McGraw-Hill Publishing Company, New York.
3. *Boyce and DiPrima,* **"Elementary Differential Equations and Boundary Value Problems",** Seventh Edition, 2001, John Wiley.

17PMT13D	CORE - IV: NUMERICAL ANALYSIS	SEMESTER - I

PREAMBLE:

- To solve the system of nonlinear equations using various numerical methods.
- To solve the ordinary and Partial Differential Equations.

COURSE OUTCOMES:

On the successful completion of the course, the student will be able to

CO Number	CO Statement	Knowledge Level
CO1	Find the numerical solution of nonlinear equations	**K1**
CO2	Solve the set of equations	**K2**
CO3	Know the concept of numerical differentiation and integration	**K3**
CO4	Solve the Ordinary Differential Equations	**K4**
CO5	Solve the Parabolic and Hyperbolic Partial differential equations	**K5**

Mapping with Program Outcomes:

CO's/POS	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	S	S
CO2	S	S	S	S	S
CO3	S	S	S	S	S
CO4	S	S	S	S	S
CO5	S	S	S	S	S

S-Strong; m-Medium; L-Low

17PMT13D	CORE - IV: NUMERICAL ANALYSIS	SEMESTER - I

Total Credits: 4
Hours per Week: 6

CONTENT

UNIT - I

Solving Nonlinear Equations: Interval Halving (Bisection) Revisited - Linear Interpolation Methods - Newton's Method - Fixed - Point Iteration: $x = g(x)$ Method - Newton's Method for Polynomials - Bairstow's Method for Quadratic Factors.

UNIT – II

Solving Sets of Equations: Applications of Sets of Equations - Matrix Notation - The Elimination Method - The Gaussian Elimination and Gauss - Jordan Methods - Other Direct Methods - Iterative Methods - The Relaxation Method.

UNIT – III

Numerical Differentiation and Numerical Integration: Extrapolation Techniques - Newton - Cotes Integration Formulas - The Trapezoidal Rule-A Composite Formula - Simpson's Rules - Gaussian Quadrature.

UNIT - IV

Numerical Solution of Ordinary Differential Equations: The Spring-Mass Problem-A Variation - The Taylor-Series method - Euler and Modified Euler Methods - Runge-Kutta methods - Milne's method - The Adams-Moulton Method - Convergence Criteria.

UNIT – V

Parabolic and Hyperbolic Partial-Differential Equations: Types of Partial Differential equations - The Heat Equation and the Wave Equation - Solution Techniques for the Heat Equation in one Dimension - Solving the Vibrating String Problem - Parabolic Equations in Two or Three Dimensions.

TEXT BOOKS:

1. *Curtis F.Gerald and Patrick O.Wheatley,* "**Applied Numerical Analysis",** Sixth Edition, 1999, Pearson Education Asia, New Delhi.

Unit – I	: Chapter 1: Sections 1.2 to 1.4, 1.6 - 1.8.
Unit – II	: Chapter 2: Sections 2.1 to 2.5, 2.10 and 2.11.
Unit – III	: Chapter 5: Sections 5.4 to 5.7, 5.9
Unit – IV	: Chapter 6: Section 6.1 to 6.4., 6.6 - 6.8
Unit – V	: Chapter 8: Sections: 8.1 to 8.5

REFERENCE BOOKS:

1. *D. Samuel Conte, Carl. De Boor,* **"Elementary Numerical Analysis",** 1983, McGraw- Hill International Edition.
2. *Gordon D Smith,* **"Numerical Solution of Partial Differential Equations – Finite Difference Methods"**, 1985, Oxford University Press.
3. *M.K. Jain, S.R.K. Iyengar and R.K. Jain,* **"Numerical Methods for Scientific and Engineering Computation",** Third Edition, 1993, Wiley Eastern Ltd.

17PMT23A	CORE - V: COMPLEX ANALYSIS	SEMESTER – II

PREAMBLE:

1. To lay the foundation for topics in Advanced Complex Analysis.
2. To develop clear thinking and analyzing capacity for research.

COURSE OUTCOMES:

On the successful completion of the course, student will be able to

CO Number	CO Statement	Knowledge Level
CO 1	Learn the Riemann Mapping Theorem, infinite products and canonical products, Schwarz – Christoffel Formula	**K3**
CO 2	Summarize the Concept of Analytic Function and Linear Transformations.	**K3**
CO 3	Explain Complex Integration in Cauchy theorem, integral formula	**K4**
CO 4	Solve the relate problems Calculus of Residues and Evaluation of definite integrals	**K4**
CO 5	Compare Taylor Series and The Laurent Series	**K5**

Mapping with Program Outcomes:

COS/POS	PO1	PO2	PO3	PO4	PO5
CO1	S	M	S	S	S
CO2	S	M	S	S	S
CO3	S	S	S	S	S
CO4	S	S	S	S	S
CO5	S	S	S	S	S

S-Strong; M-Medium; L-Low

17PMT23A	CORE - V: COMPLEX ANALYSIS	SEMESTER – II

Total Credits: 4
Hours per Week: 5

CONTENT

UNIT - I

Introduction to the Concept of Analytic Function: Limits and Continuity – Analytic functions – Polynomials – Rational functions. **Conformality:** Arcs and Closed Curves – Analytic Functions in Regions – Conformal Mapping – Length and Area. **Linear Transformations:** The Linear Group – The Cross Ratio.

UNIT - II

Complex Integration: Fundamental Theorems: Line Integrals-Rectifiable Arcs – Line Integrals as Functions of Arcs – Cauchy's Theorem for a Rectangle - Cauchy's Theorem in a Disk. **Cauchy's Integral formula:** The Index of a Point with Respect to a Closed Curve – The Integral Formula – Higher Derivatives. **Local Properties of Analytical Functions:** Removable singularities - Taylor's Theorem – Zeros and Poles – The Local Mapping – The Maximum Principle.

UNIT - III

The Calculus of Residues: The Residue Theorem – The Argument Principle – Evaluation of Definite Integrals. **Harmonic Functions:** Definitions and Basic Properties – The Mean-value Property – Poisson's Formula.

UNIT - IV

Series and Product Developments: Power Series Expansions: Weierstrass's Theorem – The Taylor Series – The Laurent Series. **Partial fractions and Factorization:** Partial Fractions – Infinite Products – Canonical Products.

UNIT - V

Conformal Mapping Dirichlet's Problem: The Riemann Mapping Theorem – Statement and Proof – Boundary Behaviour – Use of the Reflection Principle – Analytic Arcs.

Conformal mapping of Polygons: The Behaviour at an Angle – The Schwarz-Christoffel Formula – Mapping on a Rectangle.

TEXT BOOKS:

1. *Lars V. Ahlfors,* "**Complex Analysis",** Third Edition, 1979, Mc Graw-Hill Book Company, New York.

Unit – I	:	Chapter – 2 Sections 1.1 – 1.4 & Chapter – 3 Sections 2.1 – 2.4, 3.1, 3.2
Unit – II	:	Chapter – 4 Sections 1.1 – 1.5, 2.1 – 2.3, 3.1 - 3.4
Unit – III	:	Chapter – 4 Sections 5.1 – 5.3, 6.1 – 6.3
Unit – IV	:	Chapter – 5 Sections 1.1 – 1.3, 2.1 – 2.3
Unit – V	:	Chapter – 6 Sections 1.1 – 1.4, 2.1 – 2.3

REFERENCE BOOKS:

1. *John B.Conway,* "**Functions of one Complex variable",** Second Edition, Narosa Publications House.
2. *Joseph Bak, Donald J. Newman,* **"Complex Analysis",** Third Edition, 2010, Springer, New York.

17PMT23B	CORE - VI : PARTIAL DIFFERENTIAL EQUATIONS	SEMESTER - II

PREAMBLE:

1. To give an introduction to Mathematical techniques in analysis of Partial Differential Equations.
2. To know about the concepts behind Boundary value problems

COURSE OUTCOMES:

On the successful completion of the course, the student will be able to

CO Number	CO Statement	Knowledge Level
CO1	Find the numerical solution of nonlinear equations	**K1**
CO2	Solve the set of equations	**K2**
CO3	Know the concept of numerical differentiation and integration	**K3**
CO4	Solve the Ordinary Differential Equations	**K4**
CO5	Solve the Parabolic and Hyperbolic Partial differential equations	**K5**

Mapping with Program Outcomes

CO's/PO's	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	M	S
CO2	S	S	S	S	S
CO3	S	M	S	L	S
CO4	S	S	S	S	S
CO5	S	S	S	M	S

S-Strong; M-Medium; L-Low

17PMT23B	CORE - VI : PARTIAL DIFFERENTIAL EQUATIONS	SEMESTER - II

Total Credits: 4
Hours per Week: 6

CONTENT

UNIT - I

Mathematical Models: Classical Equations – The Vibrating String – The Vibrating Membrane – Conduction of Heat in Solids. **Classification of Second-order Linear Equations:** Second Order Equations in Two Independent Variables – Canonical Forms – Equations with Constant Coefficients.

UNIT - II

The Cauchy Problem and Wave Equations: The Cauchy Problem – The Cauchy-Kowalewskay Theorem – Homogeneous Wave Equations – Initial Boundary-Value Problems – Equations with Nonhomogeneous Boundary Conditions – Non-homogeneous Wave Equations.

UNIT – III

Method of Separation of Variables: Separation of Variables – The Vibrating String Problem – Existence and Uniqueness of Solution of the Vibrating String Problem - The Heat Conduction Problem – Existence and Uniqueness of Solution of the Heat Conduction Problem – The Laplace and Beam Equations.

UNIT - IV

Boundary-Value Problems and Applications: Boundary-Value Problems – Maximum and Minimum Principles – Uniqueness and Continuity Theorems

– Dirichlet Problems for a Circle – Neumann Problem for a Circle - Dirirchlet Problem for a Rectangle – Neumann Problem for a Rectangle.

UNIT - V

Green's Functions and Boundary-Value Problems: The Dirac Delta Functions – Properties of Green's Functions – Method of Green's Functions – Dirichlet's Problem for the Laplace Operator.

TEXT BOOKS:

1. *Tyn Myint-U and Lokenath Debnath*, **"Linear Partial Differential Equations for Scientists and Engineers",** Fourth Edition, 2007, Birkhavser Boston.

Unit – I	:	Chapter 3: Section 3.1 to 3.3, 3.5, 4.1 to 4.3
Unit – II	:	Chapter 5: Section 5.1 to 5.5, 5.7
Unit – III	:	Chapter 7: Section 7.2 - 7.7
Unit – IV	:	Chapter 9: Section 9.1 to 9.4, 9.6 to 9.7, 9.9
Unit – V	:	Chapter 11: Section 11.2 to 11.5

REFERENCE BOOKS:

1. *Ian. N. Sneedon,* **"Elements of Partial Differential Equations",** 1957, Mc Graw-Hill, London.

2. *Aslak Tveito, Ragnar Winther,* **"Introduction to Partial Differential Equations: A Computational Approach",** 1998, Springer-Verlag, New York.

17PMT23C	CORE - VII: TOPOLOGY	SEMESTER–II

PREAMBLE:

1. To give an insight into Topological space.
2. To understand the concept of countability.

COURSE OUTCOMES:

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Explain about Topological spaces	**K2**
CO2	Analyzing Pathwise connectedness	**K4**
CO3	Analyzing Meterizability	**K4**
CO4	Comparing Properties of Spaces and Maps	**K5**
CO5	Application of Topological properties	**K5**

Mapping with program Outcomes:

COS/POS	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	M	S
CO2	S	M	S	S	S
CO3	S	S	S	M	S
CO4	S	S	S	M	S
CO5	S	M	S	S	S

S-Strong; M- Medium; L-Low.

17PMT23C	CORE - VII: TOPOLOGY	SEMESTER–II

Credits: 4
Hours per Week: 6

CONTENTS

UNIT - I

Sets and Functions: Sets – Functions – Cartesian products. **Spaces and Maps:** Topological spaces – Sets in space – Maps – Subspaces – Sum and product of spaces.

UNIT - II

Properties of Spaces and Maps: Separation of axioms – Compactness.

UNIT - III

Connectedness – Pathwise connectedness – Imbedding theorems – Extension theorems

UNIT - IV

Compactification. **Metric Spaces:** Distance function – Metric spaces - Meterizability

UNIT - V

Topological properties - Compact subsets – Completeness

TEXT BOOKS:

1. Sze-Tsen *Hu,* **"Introduction to General Topology",** 1966, Holden-Day series in Mathematics

   Unit – I : Chapter I: Sections 1 - 3 & Chapter II: Sections 1 - 5

   Unit – II : Chapter III: Sections 1 – 2,

   Unit – III : Chapter III: Sections 4 - 7

   Unit – IV : Chapter III: Sections 8 & Chapter IV: Sections 1 - 3

   Unit – V : Chapter IV: Sections 4 - 5, 7

REFERENCE BOOKS:

1. *James R.Munkres,* **"Topology",** Second Edition, 2007, Prentice-Hall of India Private Limited, New Delhi.
2. Sze-Tsen *Hu,* "**Elements of General Topology"**, 1964, Holden - Day series in Mathematics.

17PMT23D	CORE VIII: MATHEMATICAL SOFTWARES	SEMESTER – II

PREAMBLE:

- To provide an efficient introduction to software skills that is genuinely used in document preparation.
- To understand the basic structures of various build - in functions both Latex and MATLAB

COURSE OUTCOMES:

On the successful completion of the course, the student will be able to

CO Number	CO Statement	Knowledge Level
CO1	Learn how to use LaTeX to formating text in various ways	**K1**
CO2	Learn how to use LaTeX to format mathematical equations	**K2**
CO3	Know how to use LaTeX for preparing tables	**K3**
CO4	Understand the basic concept of MATLAB	**K4**
CO5	Plots and export figures and use in reports and presentations	**K5**

Mapping with Program Outcomes:

CO's/POS	PO1	PO2	PO3	PO4	PO5
CO1	S	L	S	L	M
CO2	S	S	S	M	M
CO3	S	S	S	M	M
CO4	L	S	S	S	M
CO5	L	S	S	S	M

S-Strong; m-Medium; L-Low

17PMT23D	CORE VIII: MATHEMATICAL SOFTWARES	SEMESTER – II

Total Credits: 4
Hours per Week: 4

CONTENT

UNIT - I

LATEX: Basics: Introduction to LATEX: Pros and Cons – Basics - Document Hierarchy - Document Management - Labels and Cross-references - Controlling the Style of References - The Bibliography - Table of Contents and Lists of Things - Class Files – Packages - Useful Classes and Packages - Errors and Troubleshooting. **Basic Typesetting: Running Text:** Special Characters – Diacritics – Ligatures - Quotation Marks – Dashes - Full Stops – Ellipsis – Emphasis - Borderline Punctuation - Footnotes and Marginal Notes - Displayed Quotations and Verses - Line Breaks - Controlling the Size - Seriffed and Sans Serif Typefaces - Small Caps Letters - Controlling the Type Style – Abbreviations - Phantom Text – Alignment.

UNIT - II

Tables, Diagrams, and Data Plots: Presenting External Pictures: The figure Environment - Special Packages - Floats - Legends - External Picture Files - The graphicx Package - Setting Default Key Values - Setting a Search Path - Graphics Extensions. **Presenting Diagrams:** Why Specify your Diagrams? - The tikzpicture Environment - The \tikz Command - Grids - Paths - Coordinate Labels - Extending Paths - Actions on Paths - Nodes and Node

Labels - The spy Library - Trees. **Presenting Data in Tables:** Why Use Tables? - Table Taxonomy - Table Anatomy - Table Design - Aligning Columns with Numbers - The table Environment - Wide Tables - Multi-page Tables - Databases and Spreadsheets. **Presenting Data with Plots:** The Purpose of Data Plots - Pie Charts - Introduction to pgfplots - Bar Graphs - Paired Bar Graphs - Component Bar Graphs - Coordinate Systems - Line Graphs - Scatter Plots.

UNIT - III

Mathematics and Algorithms: Mathematics: The AMS-LaTEX Platform - LaTEX's Math Modes - Ordinary Math Mode - Subscripts and Superscripts - Greek Letters - Display Math Mode - Text in Formulae – Delimiters – Fractions - Sums, Products, and Friends - Existing Functions and Operators - Integration and Differentiation – Roots - Changing the Style - Symbol Tables. **Advanced Mathematics:** Declaring New Operators - Managing Content with the cool Package - Arrays and Matrices - Accents, Hats, and Other Decorations – Braces - Case-based Definitions - Function Definitions – Theorems - Mathematical Punctuation - Spacing and Linebreaks. **Beamer Presentations:** Frames - Modal Presentations - Incremental Presentations - Visual Alerts - Adding Some Style.

UNIT – IV

MATLAB: Introduction: Basics of MATLAB. **Iterative Computation:** Matrices and Vectors – Matrix and Array Operations – Command Line Functions – Saving and Loading Data.

UNIT - V

Applications: Linear Algebra – Curve Fitting and Interpolation – Data Analysis and Statistics – Numerical Integration – Ordinary Differential Equations. **Graphics:** Basic 2-D Plots – 3-D Plots

TEXT BOOKS:

1. *M.R.C. Van Dongen,* **"LATEX and Friends",** 2012, Springer-Verlag Berlin Heidelberg, New York.

   Unit – I : Chapter 1: Sections 1.1-1.12 &
   Chapter 2: Sections 2.1-2.19

   Unit – II : Chapter 4: Sections 4.1-4.7,
   Chapter 5: Sections 5.1-5.11
   Chapter 6: Sections 6.1-6.9 &
   Chapter 7: Sections 7.1- 7.9

   Unit – III : Chapter 8: Sections 8.1-8.15,
   Chapter 9: Sections 9.1-9.10 &
   Chapter 14: Sections 14.1-14.5

2. *Rudra Pratap,* **"Getting started with MATLAB 7 A Quick Introduction for Scientists and Engineers",** 2006, Oxford University Press.

   Unit – IV : Chapter 1: Section 1.6 &
   Chapter 3: Sections 3.1-3.2, 3.4, 3.6

   Unit – V : Chapter 5: Sections 5.1-5.5
   Chapter 6: Sections 6.1, 6.3

REFERENCE BOOKS:

1. *Stefan Kottwitz,* **"LATEX Beginner's Guide",** 2011, Packt Publishing Limited, UK.
2. *H. Kopka and P.W. Daly,* "**A Guide to LATEX",** Third Edition, 1999, Addison Wesley, London.
3. *K.B.M. Nambudiripad,* **"LATEX for Beginners",** 2014, Narosa Publishing House Private Limitted, New Delhi.
4. *Y. Kirani Singh and B.B. Chaudhuri,* **"MATLAB Programming",** First Edition, 2007, PHI Learning, New Delhi.

17PMT23P	CORE LAB I: MATHEMATICAL SOFTWARES	SEMESTER – II

PREAMBLE:

1. To give the basic structure of LaTeX.
2. To give, how to use LaTeX to format mathematical equations.
3. To give the fundamental concepts of Scientific Programming using MATLAB
4. To give the syntax and semantics of MATLAB including data types, control structures, comments, variables, functions, and other abstraction mechanisms

COURSE OUTCOMES:

On the successful completion of the course, the student will be able to

CO Number	CO Statement	Knowledge Level
CO1	Prepare a Latex document	**K1**
CO2	Type a mathematical equations	**K2**
CO3	Prepare presentation using LaTeX	**K3**
CO4	Learn the basic concepts of MATLAB	**K4**
CO5	Solve mathematical equations	**K5**

Mapping with Program Outcomes:

CO's/POS	PO1	PO2	PO3	PO4	PO5
CO1	S	L	S	L	M
CO2	S	S	S	M	M
CO3	S	S	S	M	M
CO4	L	S	S	S	M
CO5	L	S	S	S	M

S-Strong; M-Medium; L-Low

17PMT23P	CORE LAB I: MATHEMATICAL SOFTWARES	SEMESTER – II

Total Credits: 2
Hours per Week: 3

LIST OF PROGRAMS

LATEX

1. Creating a document with paragraph alignment.
2. Creating a document with tables.
3. Inserting a graph or picture in a document.
4. Creating a document with Mathematical formulas.
5. Creating a PPT using Latex
6. Creating a simple project using Latex
7. Time table preparation in LaTex.
8. Creating a question paper model

MATLAB

9. Generating Fibonacci numbers
10. Solving a first order differential equation using Euler's method
11. Finding the factorial value of a given number
12. Solving a first order differential equation using Runge-Kutta fourth order method
13. Designing a Simple Plot
14. Solving a quadratic equation
15. Solving a system of equations using Gauss elimination method.
16. Solving a system of equations using Gauss Seidal method.
17. Solve the integral using Trapezoidal method.
18. Solve the integral using Simpson’s one third rule

17PMT33A	CORE –IX: FUNCTIONAL ANALYSIS	SEMESTER–III

PREAMBLE:

1. The students should gain knowledge about the Banach Spaces.
2. To understand the concept operators.

COURSE OUTCOMES:

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Explain about Banach spaces	**K3**
CO2	Analyzing Banach theorem	**K4**
CO3	Analyzing the spectral theorem	**K4**
CO4	Comparing Normal and Unitary operators	**K5**
CO5	Understand the concept operators	**K3**

Mapping with program Outcomes:

COS/POS	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	M	S
CO2	S	S	M	S	S
CO3	S	S	S	M	S
CO4	S	M	S	S	S
CO5	S	S	S	M	S

S-Strong; M- Medium; L-Low

17PMT33A	CORE –IX: FUNCTIONAL ANALYSIS	SEMESTER–III

Credits: 4
Hours per Week: 6

CONTENTS

UNIT - I

Banach spaces – The definition and some examples – Continuous linear transformations – The Hahn - Banach theorem – The natural imbedding of N in N** - The open mapping theorem.

UNIT - II

The conjugate of an operator – Hilbert spaces – The definition and some simple properties – Orthogonal complements - Orthonormal sets.

UNIT - III

The Conjugate space H* - The adjoint of an operator – Self-adjoint operators – Normal and Unitary operators – Projections.

UNIT - IV

Matrices – Determinants and the spectrum of an operator – The spectral theorem.

UNIT - V

The definition and some examples of Banach algebra – Regular and singular elements – Topological divisors of zero – The spectrum – The formula for the spectral radius.

TEXT BOOK:

1. *G.F. Simmons,* **"Introduction to Topology and Modern Analysis",** 2004, McGraw-Hill Book Company, New Delhi.

   Unit - I : Sections: 46 – 50.

   Unit - II : Sections: 51 – 54.

   Unit - III : Sections: 55 – 59.

   Unit - IV : Sections: 60 – 62.

   Unit - V : Sections: 64 – 68.

REFERENCE BOOKS:

1. *D. Somasundaram,* **"A First course in Functional Analysis",** 2006, Narosa Publishing house Pvt. Ltd.
2. *A.R. Vasishtha and J.N. Sharma,***"Functional Analysis"**, 1975, Krishna Prakashan Media PVT. Ltd.

17PMT33B	CORE - X: MECHANICS	SEMESTER – III

PREAMBLE:

1. The students should have understood the concepts of: Lagrange's Equations,
2. The students should have understood the concepts of: Hamilton's Equations.

COURSE OUTCOMES:

On the successful completion of the course, the student will be able to

CO Number	CO Statement	Knowledge Level
CO1	Learn about the Mechanical system and its basic characterstics	**K2**
CO2	Solving the Mechanical problems using Lagarange's equations	**K2**
CO3	Understand the concept of Hamilton's equations and its applications	**K3**
CO4	Learn about Jacobi's theory on systems and its applications	**K5**
CO5	Applying Canonical transformations for generating functions	**K5**

Mapping with Program Outcomes:

CO's/POS	PO1	PO2	PO3	PO4	PO5
CO1	S	M	S	S	S
CO2	S	M	S	S	S
CO3	S	S	S	S	S
CO4	S	S	S	M	S
CO5	S	S	S	S	S

S-Strong; M-Medium; L-Low

17PMT33B	CORE - X: MECHANICS	SEMESTER – III

Total Credits: 4
Hours per Week: 6

CONTENT

UNIT – I

Introductory Concepts: The Mechanical System – Generalized Coordinates – Constraints – Virtual Work – Energy and Momentum.

UNIT – II

Lagrange's Equations: Derivations of Lagrange's Equations - Examples – Integrals of the Motion.

UNIT – III

Hamilton's Equations: Hamilton's Principle – Euler – Hamilton's Equations.

UNIT – IV

Hamilton-Jacobi Theory: Hamilton's Principle Function –The Hamilton-Jacobi Equation – Seperability.

UNIT – V

Canonical Transformations: Differential Forms and Generating Functions – Lagrange and Poisson Brackets.

TEXT BOOK:

1. *Donald T. Greenwood,* **"Classical Dynamics",** 1977, Dover Publication, New York.

   Unit – I : Chapter 1: Sections 1.1 – 1.5

   Unit – II : Chapter 2: Sections 2.1 – 2.3

   Unit – III : Chapter 4: Sections 4.1 – 4.2

   Unit – IV : Chapter 5: Sections 5.1 – 5.3

   Unit – V : Chapter 6: Sections 6.1, 6.3

REFERENCE BOOKS:

1. *Herbert Goldstein,* **"Classical Mechanics",** 2001, Narosa Publishing house, New Delhi.

2. *Sankara Rao,* **"Classical Mechanics",** 2000, PHI Learning Private Limited

17PMT33C	CORE - XI: MATHEMATICAL STATISTICS	SEMESTER–III

PREAMBLE:

- To understand the concepts of the Estimation theory.
- To understand the concept of Design and Analysis of Experiments.

COURSE OUTCOMES:

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Explain about the Estimation theory	**K2**
CO2	Analyzing difference between the Hypothesis testing	**K4**
CO3	Analyzing the test of Goodness of fit	**K4**
CO4	Comparing analysis of Experiment	**K5**
CO5	Application of Non-parametric test	**K5**

Mapping with program Outcomes:

COS/POS	PO1	PO2	PO3	PO4	PO5
CO1	M	S	S	S	S
CO2	S	S	M	S	S
CO3	S	S	S	S	S
CO4	S	M	S	S	M
CO5	S	M	S	M	S

S-Strong; M- Medium; L-Low.

17PMT33C	CORE - XI: MATHEMATICAL STATISTICS	SEMESTER–III

Credits: 4
Hours per Week: 6

CONTENTS

UNIT – I

Point Estimation: Introduction - Unbiased Estimators - Efficiency - Consistency - Sufficiency - Robustness - The Method of Moments - The Method of Maximum Likelihood - Bayesian Estimation. **Interval Estimation:** Introduction - The Estimation of Means - The Estimation of Difference Between Means – The Estimation of Proportions - The Estimation of Difference Between Proportions – The Estimation of Variance – The Estimation of the ratio of Two Variances – The Theory in Practice.

UNIT – II

Hypothesis Testing: Introduction - Testing a Statistical Hypothesis - Losses and Risks - The Neyman-Pearson Lemma - The Power Function of a Test - Likelihood Ratio Test – The Theory in Practice

UNIT – III

Tests of Hypothesis Involving Means, Variances and Proportions: Introduction - Tests Concerning Means - Tests Concerning difference between Means - Tests Concerning Variances – The Concerning Proportions - Tests Concerning Differences Among k-Proportions - The Analysis of an r x c Table - Goodness of Fit – The Theory in Practice.

UNIT – IV

Design and Analysis of Experiments: Introduction – One-way Designs – Randomized-Block Design - Factorial Experiments - Multiple Comparisons - Other Experimental Designs – The Theory in Practice.

UNIT – V

Non Parametric Tests: Introduction - The Sign Test - The Signed-Rank Test - Rank-Sum Tests: The U Test - Rank-Sum Tests: The H Test – Tests Based on Runs - The Rank Correlation Coefficient - The Theory in Practice.

TEXT BOOK:

1. *Irwin Miller and Marylees Miller,* **"John E. Freund's Mathematical Statistics with Applications",** Seventh Edition, 2007, Prentices-Hall India Pvt Ltd, New Delhi.

   Unit –I : Section 10.1 to 10.9 11.1 to 11.8

   Unit –II : Section 12.1 to 12.7

   Unit –III : Section 13.1 to 13.9

   Unit –IV : Section 15.1 to 15.7

   Unit –V : Section 16.1 to 16.8

REFERENCE BOOKS:

1. *Hogg and Craig,* **"Introduction to Mathematical Statistics",**2003 Pearson Education

2. *J.M. Kapur and H.C. Saxena,* **"Mathematical Statistics",** 2001, S. Chand & Co, New Delhi

17PMT33D	CORE - XII: STOCHASTIC DIFFERENTIAL EQUATIONS	SEMESTER–III

Preamble:

- To understand the concepts of the Stochastic theory
- To gain knowledge about the method of obtaining solution of differential equations raised in random environment.

Course outcomes:

In the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	To learn about the construction of Ito integral	**K3**
CO2	Analyze and solve a SDE through Ito's formula	**K4**
CO3	Analyze the situations through Markov property	**K4**
CO4	Application of diffusion theory in various real time problems raised under uncertain situations	**K5**
CO5	Application of diffusion theory in various forms of Optimal stopping problems	**K5**

Mapping with program Outcomes:

COS/POS	PO1	PO2	PO3	PO4	PO5
CO1	M	S	M	S	S
CO2	M	S	S	S	S
CO3	S	S	S	S	M
CO4	S	M	S	S	S
CO5	S	M	S	M	S

S-Strong; M- Medium; L-Low.

17PMT33D	CORE - XII: STOCHASTIC DIFFERENTIAL EQUATIONS	SEMESTER–III

Credits: 4
Hours per Week: 6

CONTENTS

UNIT – I

Some Mathematical Preliminaries: Probability Spaces, Random Variables and Stochastic Processes - An Important Example: Brownian Motion. **Itô Integrals:** Construction of the Itô Integral - Some Properties of the Itô Integrals - Extensions of the Itô Integrals.

UNIT – II

The Itô Formula and the Martingale Representation Theorem: The 1-Dimensional Itô Formula - The Multi-dimensional Itô Formula - The Martingale Representation Theorem. **Stochastic Differential Equations:** Examples and Some Solution Methods - An Existence and Uniqueness Result - Weak and Strong Solutions.

UNIT – III

Diffusions: Basic Properties: The Markov Property - The Strong Markov Property - The Generator of an Itô Diffusion - The Dynkin Formula - The Characteristic Operator.

UNIT – IV

Other Topics in Diffusion Theory: Kolmogorov's Backward Equation. The Resolvent - The Feynman-Kac Formula. Killing - The Martingale Problem -

When is an Itô Process a Diffusion? - Random Time Change - The Girsanov Theorem.

UNIT – V

Application to Optimal Stopping: The Time-Homogeneous Case - The Time-Inhomogeneous Case - Optimal Stopping Problems Involving an Integral - Connection with Variational Inequalities.

TEXT BOOK:

1. *Bernt Øksendal,* **"Stochastic Differential Equations: An Introduction with Applications",** Sixth Edition, 2003, Springer-Verlag,.

   Unit – I : Chapter 2: Sections 2.1 - 2.2 & Chapter 3: Sections 3.1 -3.3

   Unit – II : Chapter 4: Sections 4.1 - 4.3 & Chapter 5: Sections 5.1 -5.3

   Unit – III : Chapter 7: Sections 7.1 - 7.5

   Unit – IV : Chapter 8: Sections 8.1 - 8.6

   Unit – V : Chapter 10: Sections 10.1 - 10.4

REFERENCE BOOKS:

1. *Lawrence C. Evans,* **"An Introduction to Stochastic Differential Equations",** 2012, American Mathematical Society, USA.
2. ***Xuerong Mao,*** **"Stochastic Differential Equations and Applications", 2007, WP Wood head publishing, New Delhi.**

17PMT1EA	ELECTIVE - I: FUZZY SETS AND FUZZY LOGIC	SEMESTER–I

PREAMBLE:

- Know the notion and concepts of fuzzy sets
- Know the operations of fuzzy
- Use fuzzy arithmetic and possibility theory

COURSE OUTCOMES:

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Learn about the crisp and fuzzy sets	**K1**
CO2	Learn the fuzzy operations	**K3**
CO3	Find fuzzy arithmetic	**K2**
CO4	Learn about uncertainity and possibility theory	**K1**
CO5	Applications of fuzzy sets	**K3**

Mapping with program Outcomes:

COS/POS	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	S	S
CO2	S	M	M	S	S
CO3	S	S	S	M	S
CO4	S	M	M	M	M
CO5	S	M	S	M	S

S-Strong; M- Medium; L-Low

17PMT1EA	ELECTIVE - I: FUZZY SETS AND FUZZY LOGIC	SEMESTER–I

Total Credits: 4
Hours per Week: 6

CONTENT

UNIT - I

From Classical (crisp) Sets to Fuzzy Sets: A Grand Paradigm Shift: Introduction - Crisp Sets: An Overview - Fuzzy Sets: Basic Types - Fuzzy Sets: Basic Concepts - Characteristics and Significance of the Paradigm Shift.

Fuzzy Sets Versus Crisp Sets: Additional Properties of α –cuts - Representations of Fuzzy Sets - 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 - Aggregation Operations.

UNIT - III

Fuzzy Arithmetic: Fuzzy Numbers - Linguistic Variables - Arithmetic Operations on Intervals - Arithmetic Operations on Fuzzy Numbers – Lattice of Fuzzy Numbers - Fuzzy Equations.

UNIT - IV

Possibility Theory: Fuzzy Measures - Evidence Theory - Possibility Theory - Fuzzy Sets and Possibility Theory - Possibility Theory versus Probability Theory.

UNIT – V

Uncertainty-Based Information: Information and Uncertainty - Nonspecificity of Crisp Sets - Nonspecificity of Fuzzy Sets - Fuzziness of Fuzzy Sets - Uncertainty in Evidence Theory - Summary of Uncertainty Measures - Principles of Uncertainty.

TEXT BOOK:

1. *George J. Klir and Bo Yuan,* **"Fuzzy Sets and Fuzzy Logic Theory and Applications",** 2006, Prentice-Hall of India Private Limited, New Delhi.

   Unit - I : Chapter 1: Sections 1.1-1.5 & Chapter 2: Sections 2.1-2.3

   Unit – II : Chapter 3: Sections 3.1 - 3.6

   Unit – III : Chapter 4: Sections 4.1 - 4.6

   Unit - IV : Chapter 7: Section 7.1-7.5

   Unit – V : Chapter 9: Sections 9.1-9.7

REFERENCE BOOKS:

1. *George J. Klir and Tina, A. Folger*, "**Fuzzy Sets Uncertainty and Information",** Fourth Printing, 1995, Prentice-Hall of India Private Limited.
2. *Guanrong Chen and Trung Tat Pham,***"Introduction to Fuzzy Sets, Fuzzy Logic, and Fuzzy Control Systems",** CRC Press, New York.

17PMT1EB	ELECTIVE I: OBJECT ORIENTED PROGRAMMING WITH C++	SEMESTER–I

PREAMBLE:

- The students should gain knowledge about the OOPS.
- To understand the concept of functions, operator overloading, classes and objects.

COURSE OUTCOMES:

On the successful completion of the course, student will be able to

CO Number	CO Statement	Knowledge Level
CO1	Learn how to use C++ to formatting text in various ways	**K1**
CO2	Learn how to use C++ to format Data types	**K2**
CO3	Know how to use C++ for Unformatted/ formatted I/O Operations	**K3**
CO4	Understand the basic concept of Classes and Objects	**K4**
CO5	Understand the basic concept of Operators overloading and Type Conversions	**K4**

Mapping with Program Outcomes:

CO's/POS	PO1	PO2	PO3	PO4	PO5
CO1	S	M	S	S	M
CO2	S	S	S	M	M
CO3	S	S	S	M	M
CO4	S	S	S	S	M
CO5	S	S	S	S	M

S-Strong; M-Medium; L-Low

17PMT1EB	ELECTIVE I: OBJECT ORIENTED PROGRAMMING WITH C++	SEMESTER–I

Total Credits: 4
Hours per Week: 6

CONTENT

UNIT – I

Principles of Object-Oriented Programming: Software Crisis – Software Evolution – A Look at Procedure-Oriented Programming – Object-Oriented Programming Paradigm – Basic Concepts of Object-Oriented Programming – Benefits of OOP – Object-Oriented Languages – Applications of OOP.

UNIT – II

Tokens, Expressions and Control Structures: Introduction – Tokens – Keywords – Identifiers and Constants – Basic Data Types – User-Defined Data Types - Derived Data Types – Symbolic Constants – Type Compatibility – Declaration of Variables – Dynamic Initialization of Variables – Reference Variables – Operations in C++ - Scope Resolution Operator – Member Dereferencing Operators – Memory Management Operators – Manipulators – Type Cast Operator – Expressions and Their Types – Special Assignment Expressions – Implicit Conversions – Operator Overloading – Operator Precedence – Control Structures.

UNIT – III

Functions in C++: Introduction – The Main Function – Function Prototyping – Call by Reference – Return by Reference - Inline Functions – Default Arguments – const Arguments – Function Overloading – Friend and Virtual Functions – Math Library Functions. **Managing Console I/O Operations:** Introduction – C++ Streams – C++ Stream Classes – Unformatted I/O Operations - Formatted Console I/O Operations – Managing Output with Manipulators.

UNIT – IV

Classes and Objects: Introduction – C Structures Revisited – Specifying a Class – Defining Member Functions – A C++ Program with Class – Making an Outside Function Inline – Nesting of Member Functions – Private Member Functions – Arrays within a class – Memory Allocation for Objects – Static Data Members – Static Member Functions – Arrays of Objects – Objects as Function Arguments – Friendly Functions – Returning Objects – const Member Functions. **Constructors and Destructors:** Introduction – Constructors – Parameterized Constructors – Multiple Constructors in a Class – Constructors with Default Arguments – Dynamic Initializations of Objects – Copy Constructor – Dynamic Constructor – Constructing Two-Dimensional Arrays – const Objects – Destructors.

UNIT – V

Operators overloading and Type Conversions: Introduction – Defining Operator Overloading – Overloading Unary Operators – Overloading Binary Operators – Overloading Binary Operators Using Friends – Manipulating of strings Using Operators – Rules of Overloading Operators.

Inheritance: Extending Classes: Introduction – Defining Derived Classes – Single inheritance – Making a Private Member Inheritable – Multilevel Inheritance – Multiple Inheritance – Hierarchical Inheritance – Hybrid Inheritance – Virtual Base Classes.

(Instructions : 4 hours theory and 2 hours practical)

TEXT BOOK:

1. *E. Balaguruswamy*, "**Object Oriented Programming with C++",** Second Edition, 2001, Tata McGraw-Hill Publishing Company limited.

   Unit – I : Chapter 1: Sections 1.1-1.8

   Unit – II : Chapter 3: Sections 3.1-3.24

   Unit – III : Chapter 4: Sections 4.1-4.11 & Chapter 10: Sections 10.1-10.6

   Unit - IV : Chapter 5: Sections 5.1-5.17 & Chapter 6: Sections 6.1-6.11

   Unit - V : Chapter 7: Sections 7.1-7.7 & Chapter 8: Sections 8.1-8.9

REFERENCE BOOKS:

1. *K.R. Venugopal, Rajkumar and Ravishankar, T.,* **"Mastering C++",** 1997, Tata McGraw - Hill Education Pvt. Limited.
2. *Herbert Schildt,* **"C++: The Complete Reference",** Fourth Edition, 2003, Tata McGraw-Hill Education Pvt. Limited.
3. *D. Ravichandran,* **"Programming with C++",** Third Edition, 2013, Tata McGraw-Hill Education Pvt. Limited.

17PMT1EC	ELECTIVE - I: ADVANCED OPERATIONS RESEARCH	SEMESTER–I

PREAMBLE:

- The students should gain knowledge about the Dynamic, Integer programming and Decision Analysis
- To understand the concept of Queuing and Simulation.

COURSE OUTCOMES:

On the successful completion of the course, student will be able to

CO Number	CO Statement	Knowledge Level
CO 1	Learn Characteristics of Dynamic Programming problem	**K3**
CO 2	Deterministic Dynamic Programming-Probabilistic Dynamic Programming	**K2**
CO 3	Learn A prototype Example for Dynamic Programming	**K1**
CO 4	Application to Binary Integer Programming.	**K3**
CO 5	Decision making with experiment	**K4**
CO 6	Obtain applications of simulation	**K5**

Mapping with Program Outcomes:

COS/POS	PO 1	PO 2	PO 3	PO 4	PO 5
CO 1	S	S	S	S	S
CO 2	S	M	S	S	M
CO 3	S	S	S	M	S
CO 4	S	S	S	S	S
CO 5	S	S	M	S	S
CO 6	S	S	S	S	S

S- Strong; M-Medium; L-Low

17PMT1EC	ELECTIVE - I: ADVANCED OPERATIONS RESEARCH	SEMESTER–I

Total Credits: 4
Hours per Week: 6

CONTENT

UNIT - I

Dynamic Programming: A prototype Example for Dynamic Programming-Characteristics of Dynamic Programming problem-Deterministic Dynamic Programming-Probabilistic Dynamic Programming

UNIT - II

Integer Programming: Prototype Example-Some BIP Applications-Innovative uses of Binary Variables in Model Formulation- Some Formulation Examples-Some Perspectives on solving Integer Programming Problem **-**The Branch and Bound Techniques and its Application to Binary Integer Programming.

UNIT - III

Decision Analysis: A Prototype Example-Decision making without experiment- Decision making with experiment-Decision trees.

Markov Chains: Stochastic Processes-Markov Chains-Champman – Kolmogorov Equations-Classification of States of Markov Chains

UNIT - IV

Queueing Theory: Prototype Example-Basic structure of Queueing Models-Examples of Real Queueing System-The Role of Exponential Distribution – The Birth – and – Death Process- Queueing Models Based on Birth – and – Death Process- Queueing Models involving Nonexponential Distributions.

UNIT - V

Simulation: The Essence of Simulation- Some common types of applications of simulation-Generation of random number-Generation of random observation from a probability distribution-Outline of a major simulation study.

TEXT BOOK:

1. *Frederick S. Hillier Gerald and J. Lieberman,* "**Operations Research: Concepts and Cases",** Thirteenth Edition, 2010, The McGraw-Hill Companies, New York.

   Unit – I : Chapter 10 (Sec 10.1-.10.4)

   Unit – II : Chapter 11 (Sec 11.1-11.6)

   Unit– III : Chapter 15 (Sec 15.1-15.4)

   Chapter 16 (Sec 16.1-16.4)

   Unit – IV : Chapter 17 (Sec 17.1-17.7)

   Unit – V : Chapter 20 (Sec 20.1-20.5)

REFERENCE BOOKS:

1. *H.A. Taha,* **"Operations Research: An Introduction",** Eighth Edition, 2006, Prentice-Hall of India Private Limited, New Delhi.
2. *Kandiswarup, P.K. Gupta and Man Mohan,* **"Operations Research",** 1998, S. Chand & Sons Education Publications, New Delhi.

17PMT2EA	ELECTIVE –II: MATHEMATICAL FINANCE	SEMESTER – II

PREAMBLE:

1. To lay theoretical foundation with potential applications to financial problems
2. To provide efficient introduction to theoretical skills that are genuinely used in financial institutions

COURSE OUTCOMES:

On the successful completion of the course, the student will be able to

CO Number	CO Statement	Knowledge Level
CO1	Learn about financial model and its representation through Binomial trees	**K1**
CO2	Compute the stock and option trees using Spreadsheets	**K2**
CO3	Understand continuous models	**K3**
CO4	Learn about Black-Scholes model for various options	**K5**
CO5	Calculate parameters corresponding to Financial model	**K5**

Mapping with Program Outcomes:

CO's/POS	PO1	PO2	PO3	PO4	PO5
CO1	S	M	S	S	M
CO2	S	M	S	S	S
CO3	S	S	S	S	S
CO4	S	S	S	S	S
CO5	S	S	S	S	S

S- Strong; M-Medium; L-Low

17PMT2EA	ELECTIVE –II: MATHEMATICAL FINANCE	SEMESTER – II

Total Credits: 4
Hours per Week: 6

CONTENT

UNIT - I

Financial Markets: Markets and Math - Stocks and their Derivatives - Pricing Futures Contracts - Bond Markets - Interest Rate Futures - Foreign Exchange. **Binomial Trees, Replicating Portfoilos and Arbitrage**: Three Ways to Price a Derivative - The Game Theory method - Replicating Portfolios - The Probabilistic approach - Risk - Repeated Binomial Trees and Arbitrage

UNIT - II

Tree Models for Stocks and Options: A Stock Model - Pricing a call Option With the Tree Model - Pricing an American Option - Pricing an Exotic Option - Knockout Options - Pricing an Exotic Option - Lookback Options - Adjusting the Binomial Tree Model to Real - World Data - Hedging and Pricing the N - Period Binomial Model. **Using Spreadsheets to Compute Stock and Option Trees**: Some Spreadsheets Basics – Computing European Trees - Computing American Option trees - Computing a Barrier Option Tree - Computing N - Step Trees.

UNIT – III

Continuous Models and the Black - Scholes Formula: A continuous – Time Stock Model - The Discrete Model - An Analysis of The Continuous

Model - The Black - Scholes Formula - Derivation of the The Black - Scholes Formula - Put - Call Parity - Trees and Continuous Models - The GBM Stock Price Model - A Cautionary Tale**.**

Unit - IV: The Analytic Approach to Black-Scholes: Strategy for Obtaining the Differential Equation - Expanding V(S,t) - Expanding and Simplifying $V(S_t, t)$ - Finding a Portfolio - Solving the Black - Scholes Differential Equation - Options on Futures - Appendix: Portfolio Differentials

UNIT - V

Hedging: Delta Hedging - Methods of Hedging a Stock or Portfolio - Implied Volatillity - The Parameters Δ, Γ and Θ - Derivation of the Delta Hedging Rule - Delta Hedging a Stock Purchase.

TEXT BOOK:

1. *Joseph Stampfli and Victor Goodman,* **"The Mathematics of Finance: Modeling and Hedging", (Brooks Cole series in Adavanced Mathematics),** 2002, Thomson Asia Private Ltd.

   Unit - I : Chapter 1: Sections 1.1 to 1.6 &
   Chapter 2: Sections 2.1 to 2.6

   Unit - II : Chapter 3: Sections 3.1 to 3.7 &
   Chapter 4: Sections 4.1 to 4.5

   Unit – III : Chapter 5: Sections 5.1 to 5.9.

   Unit - IV : Chapter 6: Section 6.1 to 6.7.

   Unit - V : Chapter 7: Sections: 7.1 to 7.6

REFERENCE BOOKS:

1. *S. Chandra, S. Dharmaraja, Paraná Mehra and R. Khemchandani*, **"Financial Mathematics – An introduction"**, 2014, Narosa Publications.
2. *J.C. Hull and Sankarshan Basu*, **"Options futures and other derivatives",** Seventh Edition, 2009, Pearson Education, New Delhi.

17PMT2EB	ELECTIVE –II: MATHEMATICAL BIOLOGY	SEMESTER – II

PREAMBLE:

1. To introduce Mathematics as a tool in the study of Biology.
2. To understand the structures of various mathematical methods that are used in Biological modeling

COURSE OUTCOMES:

On the successful completion of the course, the student will be able to

CO Number	CO Statement	Knowledge Level
CO1	Know the continuous population models for single species	**K1**
CO2	Understand the discrete population models for a single species	**K2**
CO3	Know the models for interacting populations	**K3**
CO4	Understand the concept of mathematical model for human beings	**K4**
CO5	Analyze the marital relationship between man and women	**K5**

Mapping with Program Outcomes

CO's/POS	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	S	S
CO2	S	S	S	S	S
CO3	S	S	S	S	S
CO4	S	S	S	S	S
CO5	S	S	S	S	S

S-Strong; M-Medium; L-Low

17PMT2EB	ELECTIVE –II: MATHEMATICAL BIOLOGY	SEMESTER – II

Total Credits: 4
Hours per Week: 6

CONTENTS

UNIT - I

Continuous Population Models for Single Species: Continuous Growth Models – Insect Outbreak Model: Spruce Budworm – Delay Models - Linear Analysis of Delay Population Models: Periodic Solutions - Delay Models in Physiology: Periodic Dynamic Diseases - Harvesting a Single Natural Population - Population Model with Age Distribution.

UNIT - II

Discrete Population Models for a Single Species: Introduction: Simple Models - Cobwebbing: A Graphical Procedure of Solution – Discrete Logistic - Type Model: Chaos - Stability, Periodic Solutions and Bifurcations – Discrete Delay Models – Fishery Management Model - Ecological Implications and Caveats – Tumour Cell Growth.

UNIT - III

Models for Interacting Populations: Predator–Prey Models: Lotka–Volterra Systems - Complexity and Stability – Realistic Predator–Prey Models - Analysis of a Predator–Prey Model with Limit Cycle Periodic Behaviour: Parameter Domains of Stability - Competition Models: Principle of

Competitive Exclusion – Mutualism or Symbiosis – General Models and Some General and Cautionary Remarks – Threshold Phenomena - Discrete Growth Models for Interacting Populations - Predator–Prey Models: Detailed Analysis.

UNIT - IV

Temperature - Dependent Sex Determination (TSD): Crocodilian Survivorship: Biological Introduction and Historical Asides on the Crocodilia - Basic Nesting Assumptions and Simple Population Model - Age - Structured Population Model for Crocodilia - Density - Dependent Age - Structured Model Equations - Stability of the Female Population in Wet Marsh Region.

UNIT - V

Modelling the Dynamics of Marital Interaction: Divorce Prediction and Marriage Repair: Psychological Background and Data: Gottman and Levenson Methodology - Marital Typology and Modelling Motivation - Modelling Strategy and the Model Equations - Steady States and Stability – Practical Results from the Model - Benefits, Implications and Marriage Repair Scenarios.

TEXT BOOK:

1. *J.D. Murray,* "**Mathematical Biology** I**. An Introduction"**, Third Edition, 2002, Springer

   Unit - I : Chapter 1: Sections 1.1 - 1.7

   Unit - II : Chapter 2: Sections 2.1 - 2.8

   Unit – III : Chapter 3: Sections 3.1 - 3.10

   Unit - IV : Chapter 4: Sections 4.1 - 4.5

   Unit – V : Chapter 5: Sections 5.1 - 5.6

REFERENCE BOOKS :

1. *Nicholas F. Britton,* **"Essential Mathematical Biology"**, Second Edition, 2003, Springer – Verlag.
2. *S.I. Rubinow,* **"Introduction to Mathematical Biology"**, 2003, Dover Publications

17PMT2EC	ELECTIVE –II: ACTUARIAL MATHEMATICS	SEMESTER – II

PREAMBLE:

1. To equip the students with a sample of available tools/techniques in Mathematics to study and analyze the life insurance issues.
2. To give a firsthand experience in using / experimenting with the mathematical techniques.

COURSE OUTCOMES:

On the successful completion of the course, the student will be able to

CO Number	CO Statement	Knowledge Level
CO1	Learn about the various risk models and its applications to insurance	**K1**
CO2	Compute the mortality values under survival distributions	**K2**
CO3	Identify the type of Life insurance and compute them	**K3**
CO4	Compute the life annuities under various conditions	**K5**
CO5	Analyze the premiums based on the condition of the problems	**K5**

Mapping with Program Outcomes

CO's/POS	PO1	PO2	PO3	PO4	PO5
CO1	S	M	S	S	M
CO2	S	M	S	S	S
CO3	S	S	S	S	S
CO4	S	S	S	S	S
CO5	S	S	S	S	S

S-Strong; M-Medium; L-Low

17PMT2EC	ELECTIVE –II: ACTUARIAL MATHEMATICS	SEMESTER – II

Total Credits: 4
Hours per Week: 6

CONTENT

UNIT - I

Individula Risk Models for Short Yerms: Individual Risk Model and Collective Risk Model – Models for individual claim random variable – Sum of independent random variables – Approximations – Applications to the Insurance

UNIT - II

Survival Distributions: Probability for the Age-at-Death – Life tables – The Deterministic Survivorship Group – Other Life Table Characterstics - Assumptions for Fractional Ages – Some Analytical laws of Mortality – Select and Ultimate Tables

UNIT - III

Life Insurance: Life Insurance – Insurances payable at the Moment of Death – Pure endowment, Term Insurance and Endowment Insurance - Whole Life Insurance – Deferred Insurance – Varying Benefit Insurance – Insurances payable at the End of the Year of Death - Relationship between Insurances payable at the moment of death and the end of the year of death.

UNIT – IV

Life Annuities: Life Annuities – Continuous, Temporary and Deferred Life Annuities and their Actuarial Present values – Discrete Life Annuities and its classifications – Annuities due and Annuities immediate – Present value of random variables – Life annuities with monthly payments. – Apportionable Annuities-due and Complete Annuities-Immediate.

UNIT - V

Benefit Premiums: Benefit Premiums – Premium principles – Equivalence principle – Fully continuous premiums – Fully Discrete Premiums - True monthly payment premiums – Apportionable Premiums – Accumulation Type benefits

TEXT BOOK:

1. *Bowers, Gerber, Hickman, Jones and Nesbitt,* **"Actuarial Mathematics",** Society of Actuaries: USA.

    Unit - I : Chapter 2

    Unit- II : Chapter 3

    Unit -III : Chapter 4

    Unit -IV : Chapter 5

    Unit -V : Chapter 6

REFERENCE BOOKS:

1. *D.C.M. Dickson, M.R. Herby and H.R. Waters,* **"Actuarial Mathematics for Life Contingent Risks",** Cambridge University Press, New York.
2. *I.B. Hossack, J.H. Polard and Zehnwirth,* **"Introductory Statistics with Applications in General Insurance"**, Cambridge University Press, New York.
3. *Jozef Teugels and Bjørn Sundt*, "**Encyclopedia of Actuarial Science",** John Wiley & Sons, England.
4. **Insurance Institute of India – IC 28 - Foundations of Actuarial Science.**

17PMT3EA	ELECTIVE –III: MATHEMATICAL MODELING	SEMESTER–III

PREAMBLE:

1. To give an insight on application of Mathematical concepts in real life problems.
2. To understand the concept of deterministic and stochastic form of Mathematical modeling.

COURSE OUTCOMES:

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Learn about Deterministic Analysis of Observations	**K3**
CO2	Application of Mathematical concepts in real life problems.	**K3**
CO3	Compute the real distributions	**K4**
CO4	Analyse Stochastic States	**K5**
CO5	Analyse Heat and Mass Transfer	**K5**

Mapping with program Outcomes:

COS/POS	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	S	S
CO2	S	M	S	S	S
CO3	S	S	S	M	S
CO4	S	M	S	S	S
CO5	S	S	S	M	S

S-Strong; M- Medium; L-Low.

17PMT3EA	ELECTIVE –III: MATHEMATICAL MODELING	SEMESTER–III

Credits: 4
Hours per Week: 6

CONTENTS

UNIT – I

Deterministic Analysis of Observations: Data Transformations: Linear Model – Model Development: Polynomial Models – Model Evaluation: Population Modeling – The Advantage of Modeling: Global Warming Modeling. **Stochastic Analysis of Observations:** Model Errors – Optimal Linear Models – Optimal Quadratic Models – Optimal Power and Exponential Models

UNIT – II

Deterministic States: Dimensional Analysis and Similarity - Applications of Low-Complexity – Applications of Medium Complexity-Applications: Time Measurement - Applications of High-Complexity: Lift. **Deterministic Changes:** Linear Changes – Linear Changes with Delays – Nonlinear Changes - Difference and Differential Equations.

UNIT – III

Stochastic States: Probability Density Functions – Models for Probability Density Functions – Data Analysis – Real Distribution.

UNIT – IV

Stochastic Changes: Linear Stochastic Changes – Diffusion – Brownian Motion – Population Dynamics.

UNIT – V

Deterministic Evolution: Heat and Mass Transfer: Balance – Newton's Laws of Motion: Oscillations – Population Ecology: Growth and Self-Limitation – Population Ecology: Oscillations and Collapse.

TEXT BOOK:

1. *Stefen Heinz,* **"Mathematical Modeling",** 2011, Springer-Verlag, New York.

Unit - I	: Chapter 1: Sections 1.2 - 1.5 & Chapter 2: Sections 2.2-2.5
Unit - II	: Chapter 3: Sections 3.2 - 3.5 & Chapter 5: Sections 5.2-5.5
Unit – III	: Chapter 4: Sections 4.2-4.5
Unit - IV	: Chapter 6: Sections 6.2 - 6.5
Unit – V	: Chapter 7: Sections 7.2-7.5

REFERENCE BOOKS:

1. *J.N. Kapur,* "**Mathematical Modeling"**, 1988, New Age International (P) Limited, New Delhi.
2. *M. Crossand, and A.O. Moscrcadini,* "**The Art of Mathematical Modeling"**, 1976, Ellis Harwood and John Wiley.

17PMT3EB	ELECTIVE –III: CRYPTOGRAPHY	SEMESTER–III

PREAMBLE:

1. To give an insight into Cryptography.
2. To understand the concept of Encryption and secrecy.

COURSE OUTCOMES:

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Learn about Computer Security Concepts & Steganography	**K1**
CO2	Learn about Block Cipher Design Principles	**K3**
CO3	Find the Advanced Encryption Standard	**K3**
CO4	Learn about Block Cipher Operation	**K4**
CO5	Learn about Pseudorandom Number	**K4**

Mapping with program Outcomes:

COS/POS	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	S	S
CO2	S	M	S	S	S
CO3	S	S	S	M	S
CO4	S	S	S	S	M
CO5	S	M	S	S	S

1.

S-Strong; M- Medium; L-Low.

17PMT3EB	ELECTIVE –III: CRYPTOGRAPHY	SEMESTER–III

Credits: 4
Hours per Week: 6

CONTENTS

UNIT – I

Introduction – Computer Security Concepts – The OSI Security Architecture – Security Attacks – Security Services – Security Mechanisms – A model for Network Security – Symmetric Cipher Model – Substitution Techniques – Transposition Techniques – Rotor Machines - Steganography

UNIT – II

Block Cipher Principles – The Data Encryption Standard (DES) – A DES Example – The Strength of DES – Differential and Linear Cryptanalysis – Block Cipher Design Principles.

UNIT – III

Advanced Encryption Standard (AES) : The Origin AES –AES Structure – AES Round Functions - .AES Key Expansion – An AES Example – AES Implementation

UNIT – IV

Block Cipher Operation : Multiple Encryption and Triple Des – Electronic Codebook Mode – Cipher Block Charming Mode – Cipher Feedback Mode – Counter Mode – XTS Mode for Block-Oriented Storage Devices.

UNIT – V

Pseudorandom Number Generation and Stream Ciphers : Principles of Pseudorandom Number Generation - . Pseudorandom Number Generators - Pseudorandom Number Generation Using a Block Cipher – Stream Ciphers – RC4 – True Random Numbers

TEXT BOOKS:

1. *William Stallings,* **"Cryptography and Network Security Principles and Practice, Fifth Edition", 2**011, Prentice Hall of India.

   Unit - I : Chapters 1 and 2

   Unit - II : Chapter 3

   Unit - III : Chapter 5

   Unit - IV : Chapter 6

   Unit - V : Chapter 7

REFERENCE BOOKS:

1. *V.K. Pachghare,* **"Cryptography and Information Security",** 2009, PHI Learning Private Ltd.
2. *Hans Delfs and Helmut Knebl,* **"Introduction to Cryptography",** 2002, Springer Verlag.
3. *Alfred J. Menezes, Paul C. Van Oorschot and Scott A. Vanstone,* **"Handbook of Applied Cryptography",** 2016, CRC Press

17PMT3EC	ELECTIVE - III: NEURAL NETWORKS	SEMESTER–III

PREAMBLE:

1. To give an insight into Mathematical Neuron model.
2. To understand the concept of neural networks.

COURSE OUTCOMES:

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Learn about Models of neuron	**K1**
CO2	Learn about Stability of equilibrium states	**K2**
CO3	Represent the states in Hessian matrix	**K3**
CO4	apply Network Pruning technique	**K3**
CO5	Analyze the topology preserving Maps in the Brain	**K5**

Mapping with program Outcomes:

COS/POS	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	M	S
CO2	S	S	M	S	S
CO3	S	S	S	M	S
CO4	S	M	S	S	S
CO5	S	S	S	S	M

S-Strong; M- Medium; L-Low.

17PMT3EC	ELECTIVE - III: NEURAL NETWORKS	SEMESTER–III

Credits: 4
Hours per Week: 6

CONTENTS

UNIT – I

Learning Process: Introduction – Human Brain – Models of neuron – Knowledgeable representation – comparison between ANN and BNN - Learning – Bebbian learning rule – The Boltzmann machine – Credit assignment problem – Memory – Adaptation – Statistical nature.

UNIT – II

Single layer and Multi layer Perceptron: Adaptive filtering problem – Linear least square filters – Least mean square algorithm – Learning curves – Perceptions – Perceptron convergence theorem. Multi - layer perceptron – Back propagation network and algorithm – The XOR problem - Output representation and Decision Rule.

UNIT – III

Neuro dynamics and Back propagation: Dynamical systems – Stability of equilibrium states – Attractors – Manipulation of Attractors. Back propogation and differentiation – Hessian matrix – Cross validation – Network Pruning technique – Accelerated convergence – Supervised learning as Optimization problem.

UNIT – IV

Self - Organization Maps: Introduction – Topology preserving Maps in the Brain – Two basic feature Mapping models – SOM Algorithm – Computer Simulations – Learning Vector Quantization – Adaptive Resonance theory

UNIT – V

Hopfield Models: Hopfield networks and models – Convergence proof – Relation between discrete and continuous versions of Hopfield model – Learning process – Computer experiment – Associative memory – Bidirectional Associative memory.

TEXT BOOK:

1. *T.N. Shankar,* "**Neural Network"s**, 2008, University Science Press, New Delhi .

   Unit - I : Chapters 1 and 2

   Unit - II : Chapters 3 and 4

   Unit - III : Chapters 5 and 7

   Unit - IV : Chapter 6

   Unit - V : Chapter 8

REFERENCE BOOKS:

1. *Robert J. Schalkoff,* **"Artificial Neural Network",** 1997, McGraw - Hill International Edition.
2. *Martin T. Hagan, Howard B. Demuth and Mark Beale*, **"Neural Network Design",** 2003, Vikas Publishing House, New Delhi.

17PMTSS1	SELF STUDY PAPER – I INDUSTRIAL MATHEMATICS	Semester III

Credit: 1

PREAMBLE:

1. To introduce the basic concepts of modeling and curve fitting
2. To motivate the students to develop their thinking and analyzing capacity for research

COURSE OUTCOMES:

On the successful completion of the course, the student will be able to

CO Number	CO Statement	Knowledge Level
CO1	Learn the basic concepts of the Modeling Adventures	**K1**
CO2	Solve the Problems and Recommended reading	**K2**
CO3	Know the Stability and Bifurcation	**K3**
CO4	Knowledge about Dimensional Analysis and the Pi Procedure	**K4**
CO5	Know the concept of Dimensions in Electricity and Magnetism	**K5**

Mapping with Program Outcomes:

CO's/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	S	S
CO5	S	S	S	S	M

S-Strong; M-Medium; L-Low

17PMTSS1	SELF STUDY PAPER – I INDUSTRIAL MATHEMATICS	Semester III

Credit: 1

CONTENTS

UNIT – I

Case Studies at Kaiserslautern : Molecular alignment – Acoustic identification of vehicles – The Airbag-sensor – How to judge the quality of a nonwoven fabric – Fatigue lifetime.

UNIT – II

Algorithms for Optimization: Introduction – General results about optimization – Special classes of optimization problem – Newton algorithm and its generalization – Conjugate gradient method – Variable metric methods (DFP and BFGS methods).

UNIT – III

Maxwell's Equations and Numerical Methods: Maxwell's equations – Finite element method – Boundary element method.

UNIT - IV

Monte Carlo Methods: Monte Carlo method – Quasi-Monte Carlo methods – The particle methods – A current study of the particle method.

UNIT - V

Image Processing : Image model and methods of image processing – Introduction to Fourier analysis – Wavelets with applications – Fractal image compression.

TEXT BOOK:

1. *Helmut Neunzert and Abul Hasan Siddiqi* **"Topics in Industial Mathematics Case Studies and Related Mathematical Methods",** 1998, Prentice-Hall Publishers, New Delhi

   Unit - I : Chapter I: Section 1.1 – 1.5

   Unit - II : Chapter II: Section 2.1– 2.6

   Unit - III : Chapter III: Section 3.1 – 3.3

   Unit - IV : Chapter IV: Section 4.1 – 4.4

   Unit - V : Chapter V: Section 5.1 – 5.4

17PMTSS2	SELF STUDY PAPER – II MATHEMATICS OF BIOINFORMATICS	Semester III

PREAMBLE:

1. To introduce the basic concepts of growth, relaxation and vibrations
2. To motivate the students to develop their thinking and analyzing capacity for research

COURSE OUTCOMES:

On the successful completion of the course, the student will be able to

CO Number	CO Statement	Knowledge Level
CO1	Learn about the symmetries between matrix theory and Genetic codes	**K3**
CO2	Able to represent the biological sequence, system alignment and molecular sequence in the form of theoretical computer science and rank tham.	**K3**
CO3	Relate the topological concepts with DNA structures	**K4**
CO4	Able to apply the concepts of computational geometry in the investigation of protein structures	**K4**
CO5	Analyse the biological structures using Graph theory and networks	**K5**

Mapping with Program Outcomes:

CO's/POS	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	S	S
CO2	S	S	S	S	S
CO3	S	S	S	S	S
CO4	S	S	S	S	S
CO5	S	S	S	S	S

S-Strong; M-Medium; L-Low

17PMTSS2	SELF STUDY PAPER – II MATHEMATICS OF BIOINFORMATICS	Semester III

Credit: 1

CONTENTS

UNIT - I

Genetic Codes, Matrices and Symmetical Techniques : Introduction – Matrix theory and Symmetry - Genetic Codes and Matrices - Genetic Matrices, Hydrogen Bonds and the Golden Section - Symmetical patterns, Molecular Genetics and Bioinformatics

UNIT – II

Biological Sequences and Sequence Alignment: Mathematical Sequence - Sequence Alignment and Sequence analysis.

UNIT – III

Structures of DNA and Knot Theory : Knot theory preliminaries – DNA knot and links .

UNIT – IV

Protein Structures, Geometry, and Topology : Introduction – Computational Geometry and Topology Preliminaries – Protein Structures and Prediction.

UNIT – V

Biological Networks and Graph Theory: Introduction – Graph Theory Preliminaries and Network Topology.

TEXT BOOK:

1. **Matthew He and Sergey Petoukhov**, **"Mathematics of Bioinformatics:-Theory, Practice and Applications",** 2011, John Wiley & Sons, New Jersey.

    Unit - I : Chapter 2: Sections 2.1-2.5

    Unit - II : Chapter 3: Section 3.2 – 3.4

    Unit – III : Chapter 4: Sections 4.2-4.3

    Unit – IV : Chapter 5: Sections 5.1-5.3

    Unit - V : Chapter 6: Sections 6.1-6.2

17PMT43A	CORE - XIII: FLUID DYNAMICS	SEMESTER–IV

PREAMBLE:

- To understand the concepts of the fluid motion.
- To give an insight into flow of viscous and inviscid incompressible fluids.

COURSE OUTCOMES:

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Explain about Kinematics of Fluids	**K2**
CO2	Analyzing relation between stress and strain , flow of viscous compressible fluids	**K4**
CO3	Analyzing flow of inviscid compressible fluids	**K4**
CO4	Comparing Similarity of Flows	**K5**
CO5	Application of Momentum Integral Theorems	**K5**

Mapping with program Outcomes:

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

S-Strong; M- Medium; L-Low.

17PMT43A	CORE - XIII: FLUID DYNAMICS	SEMESTER–IV

Credits: 4
Hours per Week: 6

CONTENTS

UNIT - I

Introduction: General Description of Fluid Mechanics - Continuum Mechanics - Fluid Properties - Regimes in the Mechanics of Fluids. **Kinematics of Fluids:** Methods of Describing Fluid Motion - Translation, Rotation and Rate of Deformation - Streamlines Path Lines and Streak Lines - The Material Derivative and Acceleration - Vorticity.

UNIT – II

General Theory of Stress and Rate of Strain: Nature of Stresses - Transformation of Stress-Components - Nature of Strains - Transformation of the Rates of Strain - Relation Between Stress and Rate of Strain. **Fundamental Equations of the Flow of Viscous Compressible Fluids:** The Equation of Continuity-Conservation of Mass - Equations of Motion (Navier-Stokes Equation)-Conservation of Momentum - The Energy Equation-Conservation of Energy.

UNIT – III

Two- and Three-Dimensional, Inviscid Incompressible Flow: Basic Equations and Concepts of Flows: Equation of Continuity - Eulerian Equation of Motion - Circulation Theorems - Velocity Potential-Irrotational Flow - Integration of the Equations of Motion-Bernoulli's Equation - The Momentum Theorem. **Simple Flows:** Laplace's Equation - Stream Function

in Two-Dimensional Motion - The Flow Net – Two-Dimensional Flow Examples - Three-Dimensional Axially Symmetric Flow Examples.

UNIT – IV

Laminar Flow of Viscous Incompressible Fluids: Similarity of Flows; The Reynolds Number - Viscosity from the Point of View of the Kinetic Theory - Flow Between Parallel Flat Plates - Steady Flow in Pipes - Flow Between Two Concentric Rotating Cylinders - Applications of the Parallel Flow Theory.

UNIT – V

The Laminar Boundary Layer: Properties of Navier-Stokes Equations-Boundary Layer Concept - The Boundary Layer Equations in Two-Dimensional Flow - The Boundary Layer Along a Flat Plate - Boundary Layer on a Surface with Pressure Gradient - Momentum Integral Theorems for the Boundary Layer.

TEXT BOOK:

1. *S.W. Yuan*, **"Foundations of Fluid Mechanics",** 1969, Prentice-Hall of India Private Limited, New Delhi.

   Unit – I : Sections 1.1 to 1.4 & Sections 3.1 to 3.5

   Unit – II : Sections 4.1 to 4.5 & Sections 5.1 to 5.3

   Unit – III : Sections 7.1 to 7.6, 7.8 to 7.10, 7.12-7.13

   Unit – IV : Sections 8.1 to 8.6

   Unit – V : Sections 9.1 to 9.5

REFERENCE BOOKS:

1. *L.M. Milne Thomson,* **"Theoretical Hydro Dynamics", Fifth** Edition, 1968, McMillan Company.
2. *N. Curle and H.J. Davies,* **"Modern Fluid Dynamics",** Volume I, 1968, D Van Nostrand Company Limited, London.

17PMT43B	CORE –XIV: MATHEMATICAL METHODS	SEMESTER–IV

PREAMBLE:

- The students should have understood the concepts of Mellin and Hankel transform
- The students should have understood the concepts of integral Equations.

COURSE OUTCOMES:

On the successful completion of the course, the student will be able to

CO Number	CO Statement	Knowledge Level
CO1	Learn about Mellin transform	**K1**
CO2	Learn about Hankel transform	**K1**
CO3	Explain about Integral equations	**K2**
CO4	Understand the applications of fractional derivatives	**K5**
CO5	Analyse the Eulers equation,Variations and its applications	**K5**

Mapping with Program Outcomes:

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

S-Strong; M-Medium; L-Low

17PMT43B	CORE –XIV: MATHEMATICAL METHODS	SEMESTER–IV

Credits: 4
Hours per Week: 6

CONTENTS

UNIT - I

The Mellin Transform: Elementary properties of the Mellin transform - Mellin transforms of derivatives and integrals - the Mellin inversion theorem - convolution theorems for the Mellin transform - the solution of some integral equations.

UNIT - II

Hankel Transforms: Elementary properties of Hankel Transforms – Hankel inversion theorem of derivatives of functions (proof deleted) - The Parseval's relation – relation between Fourier and Hankel transforms - Axisymmetric Dirichlet problem for a half space - Axi symmetric Dirichlet problem for a thick plate.

UNIT - III

Integral Equations: Types of Integral equations - Fredholm integral equation - Volterra integral equation - singular integral equations. special kinds of kernels - Eigen values Eigen functions – Fredholm Alternative - Approximate method .

UNIT – IV

Fractional Calculus: Riemann - Liouville differential and integral operators - Riemann-Liouville integrals – Riemann-Liouville derivatives - Relations between Riemann-Liouville integrals and derivatives – Grunwald- Letnikov operators - Caputo's approach -Definition and basic properties - Nonclassical representations of Caputo operators.

UNIT - V

Calculus Of Variations: Variation and its properties – Euler's equation – functionals of the forms - Functional dependent on higher order derivatives – functionals dependent on the functions of several independent variables – variational problems in parametric form –applications.

TEXT BOOKS:

1. *Ian. N. Sneddon,* "**The Use of Integral Transforms",** 1974, Tata Mc Graw Hill, New Delhi.

   Unit – I : Chapter IV: Sections 4.1 - 4.5

   Unit – II : Chapter V: Sections 5.1 - 5.7, 5.10.1, 5.10.2

2. *M.D. Raisinghania,* "**Integral equations and boundary value problems",** 2007, S.Chand and Company Pvt. Ltd publishers, New Delhi.

   Unit – III : Chapter I and Chapter IV

3. *Kai* Diethelm,"**The Analysis of fractional Differential Equations**" Springer, 2004.

   Unit IV : Chapter 2 and 3

4. *Elsgolts,* "**Differential Equations and Calculus of Variations,** 1970, Mir Publishers, Moscow.

   Unit – V : Chapter VI

REFERENCE BOOKS:

1. *R.P. Kanwal,* "**Linear Integral Equations Theory and Technique",** 1971, Academic Press, New York.
2. *A.S. Gupta,* "**Calculus of Variations with applications",** 1996, Prentice-Hall India Learning Private Limited, New Delhi.

17PMT43C	CORE - XV: CONTROL THEORY	SEMESTER–IV

PREAMBLE:

1. The students should gain knowledge about the observability Grammian.
2. To understand the concept of optimal control.

COURSE OUTCOMES:

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Learn about effect of fixed points in differential systems	**K3**
CO2	Gain knowledge about the observability Grammian	**K3**
CO3	Find the Stabilization via Linear Feedback Control	**K3**
CO4	Learn about concept of optimal control.	**K4**
CO5	Learn about Controllability	**K5**

Mapping with program Outcomes:

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

S-Strong; M- Medium; L-Low.

17PMT43C	CORE - XV: CONTROL THEORY	SEMESTER–IV

Credits: 4
Hours per Week: 5

CONTENTS

UNIT – I

Introduction : Basic Results of Differential Equations – Fixed Point Methods - **Observability**: Linear Systems - Nonlinear Systems

UNIT – II

Controllability: Linear systems –Nonlinear systems – Controllability with Prescribed Control – Asymptotic Null Controllability

UNIT – III

Stability: Linear system – Perturbed Linear Systems – Nonlinear Systems – Lyapunov Stability

UNIT - IV

Stabilizability: Stabilization via Linear Feedback Control – The Controllable Subspace – Stabilization with Restricted Feedback.

UNIT – V

Optimal Control: Linear Time Varying Systems – Linear Time Invariant Systems – Nonlinear Systems.

TEXT BOOK:

1. *K. Balachandran and J.P. Dauer,* "**Elements of Control Theory",** Second Edition, 2012, Reprint 2015, Narosa Publishing House, New Delhi.

   Unit - I : Chapter 1 and 2.

   Unit - II : Chapter 3

   Unit - III : Chapter 4

   Unit - IV : Chapter 5

   Unit -V : Chapter 6

REFERENCE BOOKS:

1. *Ruth F. Curtain and Hans Zwart,* "**An Introduction to Infinite - Dimensional Linear Systems Theory",** 1995, Springer, New York.
2. L.D. Berkovitz, **"Optimal Control theory"**, 1974, Springer-Verlag, New York.

17PMT43D	CORE XVI - STATISTICAL SOFTWARE	SEMESTER - IV

PREAMBLE:

- To understand the knowledge about the R-Programming Language.
- To understand the concept of Hypothesis Testing through R-language.

COURSE OUTCOMES:

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Explain the Command Package in R	**K2**
CO2	Analyzing the concept of Making Contingency Tables	**K4**
CO3	Analyzing Types of data distribution	**K4**
CO4	Application of Simple Hypothesis Testing	**K5**
CO5	Application of Analysis of Variance	**K5**

Mapping with program Outcomes:

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

S-Strong; M- Medium; L-Low.

17PMT43D	CORE XVI - STATISTICAL SOFTWARE	SEMESTER - IV

Credits : 4
Hours per week: 4

CONTENTS

UNIT - I

Introducing R: What It Is and How to Get It: Getting the Hang of R - Running the R Program - Finding Your Way with R - Command Packages. **Starting Out: Becoming Familiar with R:** Some Simple Math - Reading and Getting Data into R - Viewing Named Objects - Types of Data Items – The Structure of Data Items.

UNIT - II

Data: Descriptive Statistics and Tabulation: Summary Statistics for Vectors - Cumulative Statistics - Summary Statistics for data frames. **Summary Tables:** Making Contingency Tables – Selective Parts of a Table Object – Converting an Object into a Table – Testing for Table Objects – Cross Tabulation.

UNIT - III

Data: Distribution: Looking at the Distribution of Data: Stem and Leaf Plot - Histograms - Density function - Types of data distribution - The Shapiro-Wilk Test for Normality - The Kolmogorov-Smirov test.

UNIT - IV

Simple Hypothesis Testing: Using The Students t-test: Two-Sample t-Test with Unequal Variance - Two-Sample t-Test with Equal Variance - One-Sample t-testing. **Paired t- and U-Tests. Correlation and Covariance:** Simple Correlation **–** Covariance **–** Significance Testing in Correlation Tests **–**

Formula Syntax. **Test for Association:** Multiple Categories: Chi-Squared Tests – Single Category: Goodness of Fit Tests.

UNIT – V

Formula Notation and Complex Statistics: Analysis of Variance (ANOVA)- One Way ANOVA - Simple Post-hoc Testing - Extracting Means from aov() Models - Two-Way ANOVA - Extracting Means and Summary Statistics.

TEXT BOOK:

1.Dr. Mark Gardener, **"Beginning R The Statistical Programming Language",** 2012, John Wiley & Sons, Inc., Indianapolis, Indiana.

Unit - I : Chapter 1 and 2.

Unit - II : Chapter 4

Unit - III : Chapter 5

Unit - IV : Chapter 6

Unit -V : Chapter 8

REFERENCE BOOKS:

1. *G. Jay Kerns,* **"Introduction to Probability and Statistics Using R",** 2010, IPSUR.
2. *Matthias Kohal,* **"Introduction to Statistical Analysis With R",** 2015, The E Book Company.
3. *Brain S. Everitt,* **"A Hand book of Statistical Analysis Using R",** 2006, Taylor & Francis Group, LLC.
4. *Norman Matloff,* **"The Art of R Programming",** 2009, Chapman & Hall/CRC Taylor & Francis Group.

17PMT43P	CORE LAB II : STATISTICAL SOFTWARE	SEMESTER - IV

PREAMBLE:

- To enable students gain fundamental knowledge about the concepts of R Programming and their applications.

COURSE OUTCOMES:

On the successful completion of the course, the student will be able to

CO Number	CO Statement	Knowledge Level
CO1	Prepare R functions and data sets	**K1**
CO2	Type a mathematical equations in Correlation and Regression	**K2**
CO3	Prepare presentation using Anova Techniques	**K3**
CO4	Learn the basic concepts R- programming	**K4**
CO5	Solve mathematical equations using Test of Significance.	**K5**

Mapping with Program Outcomes:

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

S-Strong; M-Medium; L-Low

17PMT43P	CORE LAB II : STATISTICAL SOFTWARE	SEMESTER - IV

Credits : 2
Hours per week: 3

CONTENTS

1. Create and modify R data sets
2. Write their own R functions and use available package in R
3. Perform and interpret Correlation Analysis
4. Perform and interpret Simple Linear Regression
5. Perform and interpret Multiple linear Regression
6. Perform and interpret one sample z-tests
7. Perform and interpret two sample z –tests
8. Perform and interpret two sample population proportions tests
9. Perform and interpret two sample population Standard deviation tests
10. Perform and interpret one sample t – tests
11. Perform and interpret two samples t - tests
12. Perform and interpret Paired t and U –test
13. Perform and interpret Chi - Square test for 2x2 tables
14. Perform and interpret Chi - Square test for Goodness of Fit
15. Perform and interpret equality of two population variance F -test
16. Perform and interpret ANOVA techniques
17. Perform and interpret Mann-whiteney U test
18. Perform and interpret sign test

17PMT4EA	ELECTIVE - IV : DIFFERENTIAL GEOMETRY	SEMESTER – IV

PREAMBLE:

- The students should gain knowledge about the curves and arcs.
- To understand the concept of elementary theory of surface.

COURSE OUTCOMES:

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Learn about the curves and curvature	K1
CO2	Determine the solution of natural equation, Evolutes and Involutes.	K1
CO3	Find the Elementary Theory of surfaces	K3
CO4	Apply in higher dimensional objects	K4
CO5	Apply in the hyper surface	K4

Mapping with program Outcomes:

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

S-Strong; M- Medium; L-Low.

17PMT4EA	ELECTIVE - IV :DIFFERENTIAL GEOMETRY	SEMESTER – IV

Credits: 4
Hours per Week: 6

CONTENTS

UNIT - I

Helicoids - metric on a surface - direction coefficients on a surface - Orthogonal Trajectories - Isometric correspondence - Intrinsic properties.

UNIT - II

Geodesics on a Surface: Introduction - Geodesics and their Differential equations - canonical Geodesics equations - Geodesics on surfaces of revolution - Normal property of Geodesics - differential equations using normal property - Existence theorems.

UNIT - III

Geodesics on a Surface: Geodesics parallels - Geodesics polar coordinates - Geodesics curvature - gauss –Bonnet theorem - Gaussian Curvature - Surfaces of constant curvature - conformal mapping - Geodesics Mapping.

UNIT - IV

The Second Fundamental theorem: Introduction - The Second Fundamental form - Classification of points on a surface - Principle curvatures - Lines of curvature - The Dupin indicatrix.

UNIT - V

Developable Surfaces - Developables associated with space curves and curves on surfaces - Minimal surfaces - Ruled surfaces - Three fundamental forms.

TEXT BOOK:

1. *D. Somasundaram*, **"Differential Geometry A first course",** 2005, Narosa Publishing House, New Delhi

   Unit – I : Chapter 2: Sections 2.1 – 2.15

   Unit – II : Chapter 3: Sections 3.1 - 3.7,

   Unit – III : Chapter 3: Sections 3.8 - 3.17

   Unit – IV : Chapter 4: Sections 4.1 - 4.6,

   Unit – V : Chapter 4: Sections 4.7 - 4.14

REFERENCE BOOKS:

1. *S.G. Venkatachalam,* **"Differential Geometry",** 2012, Margham publications.
2. *Dirk. J. Struik,* **"Lectures on Classical Differential Geometry",** 1961, Addison Wesley Publishing Company.

17PMT4EB	ELECTIVE IV: NONLINEAR ORDINARY DIFFERENTIAL EQUATIONS	SEMESTER–IV

PREAMBLE:

- To lay the foundation for topics in non - linear ordinary differential equations.
- To develop clear thinking and analyzing capacity for advanced research.

COURSE OUTCOMES:

On the successful completion of the course,

CO Number	CO Statement	Knowledge Level
CO 1	Students will be able to understand the general plane and solution of a linear autonomous plane systems	**K1**
CO 2	Students will be able to find the Periodic solutions using Averaging Methods	**K2**
CO 3	Students will be able to solve Non-Autonomous System with Perturbation method	**K3**
CO 4	Students will be able to use Liapunov stability to solve the plane autonomous linear systems	**K4**
CO 5	Students will be able to demonstrate knowledge of the theory and application of Poincar and find the periodic solutions	**K4**

Mapping with Programme Outcomes

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5
CO 1	S	S	S	S	S
CO 2	S	S	S	S	M
CO 3	S	S	S	S	S
CO 4	S	S	S	S	S
CO 5	S	S	M	S	S

S- Strong; M-Medium ;L-Low.

17PMT4EB	ELECTIVE IV: NONLINEAR ORDINARY DIFFERENTIAL EQUATIONS	SEMESTER–IV

Credits: 4
Hours per Week: 6

CONTENTS

UNIT - I

Plane autonomous systems and linearization: The general phase plane – some population models – linear approximation at equilibrium points – The general solution of a linear autonomous plane systems.

UNIT - II

Periodic solutions; Averaging Methods: An energy-balance method for limit cycles – Amplitude and frequency estimates: polar coordinates – An averaging method for spiral phase paths - Periodic solutions: harmonic balance – The equivalent linear equation by harmonic balance.

UNIT - III

Perturbation Methods: Non-Autonomous System: forced oscillations – The direct perturbation method for the undamped Duffing's equation – Forced oscillations far from resonance - Forced oscillations near resonance with weak excitation – Amplitude – phase perturbation for the pendulum equation – Periodic solutions of autonomous equations(Lindstedt's method) – The perturbation method and Fourier series.

UNIT - IV

Stability: Poincare stability –Paths and solution curves for general systems – Stability of time solutions: Liapunov stability - Liapunov stability of plane

autonomous linear systems - Stability and boundedness for linear systems - Stability of linear system with constant coefficients.

UNIT - V

The existence of periodic solutions: The Poincare - Bendixson theorem and periodic solutions - A theorem on the existence of a centre - A theorem on the existence of a limit cycle - Van der Pol's equation with large parameter.

TEXT BOOK:

1. *D.W. Jordan and P. Smith,* **"Nonlinear Ordinary Differential Equations", Fourth** Edition, 2007, Clarendon Press, Oxford.

   Unit – I : Chapter 2: Sections 2.1 - 2.4
   Unit - II : Chapter 4: Sections 4.1 - 4.5
   Unit – III : Chapter 5: Sections 5.1 - 5.4, 5.8 - 5.9, 5.11
   Unit - IV : Chapter 8: Sections 8.1 – 8.4, 8.7-8.8.
   Unit - V : Chapter 11: Sections 11.1 – 11.4

REFERENCE BOOKS:

1. *G.F. Simmons,* "**Differential Equations",** 1979, Tata McGraw-Hill, New Delhi.
2. *D.A. Sanchez,* **"Ordinary Differential Equations and Stability Theory",** 1968, Dover, New York.

17PMT4EC	ELECTIVE –IV: COMPUTATIONAL FLUID DYNAMICS	SEMESTER–IV

PREAMBLE:

1. To understand the concept of computational fluid dynamics.
2. To solve diffusion equations by finite volume method.

COURSE OUTCOMES:

On the successful completion of the course, the student will be able to

CO Number	CO Statement	Knowledge Level
CO1	Learn the basic concepts of computational fluid dynamics	**K1**
CO2	Solve the governing equations of fluid flow	**K2**
CO3	Know the effect of laminar and turbulence flow in the system	**K3**
CO4	Understand the concept of finite volume method	**K4**
CO5	Solve the convection - diffusion problems by various scheme	**K5**

Mapping with Program Outcomes:

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

S-Strong; M-Medium; L-Low

17PMT4EC	ELECTIVE –IV: COMPUTATIONAL FLUID DYNAMICS	SEMESTER–IV

Credits: 4
Hours per Week: 6

CONTENTS

UNIT – I

Introduction: What is CFD? – How does a CFD code work? – Problem solving with CFD.

Conservation laws of fluid motion and boundary conditions: Governing equations of fluid flow and heat transfer – Equations of state – Navier-Stokes equations for a Newtonian fluid.

UNIT – II

Conservation form of the governing equations of fluid flow – Differential and integral forms of the general transport equations – Classification of physical behaviours- The role of characteristics hyperbolic equations – Classification method for simple PDE's – Classification of fluid flow equations – Problems in transonic and supersonic compressible flows.

UNIT – III

Turbulence and its modeling: What is turbulence? – Transition from laminar to turbulent flow – Descriptors of turbulent flow – Characteristics of simple turbulent flows – The effect of turbulent fluctuations on properties of the mean flow – Turbulent flow calculations – Reynolds-averaged Navier-Stokes equations and classical turbulence models.

UNIT – IV

Introduction – Finite volume method for one-dimensional steady state diffusion – Worked examples: one-dimensional steady state diffusion – Finite volume method for two-dimensional diffusion problems – Finite volume method for three-dimensional diffusion problems.

UNIT – V

The finite volume method for Convection-diffusion problems: Introduction – Steady one-dimensional convection and diffusion – The central differencing schemes – Properties of discretisation schemes – Assessment of the central differencing scheme for convection-diffusion problems – The upwind difference scheme – The hybrid differencing scheme – The power-law scheme.

TEXT BOOK:

1. *H.K. Versteeg and W. Malalasekara,* **"An Introduction to Computational Fluid Dynamics",** Second Edition, 2007, Pearson India Educational Service Private Limited, India.

    Unit – I : Chapter 1: Sections 1.1-1.4 &
    Chapter 2: Sections 2.1-2.3
    Unit - II : Chapter 2: Sections 2.4-2.11
    Unit – III : Chapter 3: Sections 3.1-3.7
    Unit - IV : Chapter 4: Sections 4.1-4.5
    Unit – V : Chapter 5: Sections 5.1-5.8

REFERENCE BOOKS:

1. *Atul Sharma,* **"Introduction to Computational Fluid Dynamics: Development, Application and Analysis"**, 2016, John Wiley & Sons Ltd, United Kingdom.
2. *Richard H. Pletcher, John C. Tannehill and Dale Anderson,* "Computational Fluid Mechanics and Heat Transfer", Third Edition, 2012, CRC Press, London.

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