# MOTHER TERESA WOMEN'S UNIVERSITY
# KODAIKANAL

## DEPARTMENT OF MATHEMATICS

## M.Sc. MATHEMATICS PROGRAMME

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

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

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

**List of Elective Courses**

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

**Reference/Text Books contain the following details:**

I. Name of the Author

**Note**

| | | | | |
|---|---|---|---|---|
| **Theory** | **Internal** | **: 25** | **External** | **: 75** |
| **Practical /viva voce** | **Internal** | **: 25** | **External** | **: 75** |

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

## SCHEME OF EXAMINATION

**Internal (Theory)** **- 25**

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

**External (Theory)** **- 75**

## QUESTION PATTERN

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

**The Internal Assessment for Practical : 25**

**The External Assessment for Practical : 75**

**Semester I**

**PMTT11 LINEAR ALGEBRA 6 Hours/5 Credits**

***Objectives:***

1. *To provide deep knowledge about various algebraic structures.*
2. *To give a depth knowledge about elementary matrix operations.*
3. *To explain the concept of eigen values and eigen vectors.*
4. *To solve linear equations easily.*

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

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

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

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

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

**Text Book**

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

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

**Reference books:**


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

**Semester I**

**PMTT12 REAL ANALYSIS- I 6 Hours/5 Credits**

***Objectives:***

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

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

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

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

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

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

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

**Text Book:**

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

**Reference Books:**


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

**Semester I**

**PMTT13 DIFFERENTIAL EQUATIONS 6 Hours /5 Credits**

***Objectives:***

1. *To give an in-depth knowledge of differential equations and their applications.*
2. *Solve the higher order differential equations in different types with initial and boundary conditions*
3. *Use the method of separation of variables to reduce some partial differential equations to ordinary differential equations of $2^{nd}$ order.*
4. *To make the students to solve the practical problems used differential equations.*

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

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

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

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

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

**Text Books:**

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

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

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

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

**Reference Books:**


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

**Semester I**

**PMTT14 GRAPH THEORY 6Hours / 5 Credits**

***Objectives:***

1. *To impart the different types of graphs.*
2. *To give a depth knowledge about matching and colourings.*
3. *To make the students to identify the varieties of graphs.*
4. *To study related theorems.*

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

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

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

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

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

**Text Book:**

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

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

**Reference Books:**


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

**Semester II**

**PMTT21 ALGEBRA 6 Hours/5 Credits**

**Objectives:**

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

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

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

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

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

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

**Text book:**

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

**Reference Books:**

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

**Semester: II**

**PMTT22** **REAL ANALYSIS-II** **6 Hours/5 Credits**

**Objectives**:

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

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

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

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

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

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

**Text book**:

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

**References Books:**


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

**Semester II**

**PMTT23 TOPOLOGY 6 Hours/5 Credits**

***Objectives:***

1. *To provide the knowledge about various varieties of topology.*
2. *To explain the concepts of topology.*
3. *To know some basic theorems.*
4. *To train the students to develop analytical thinking.*

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

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

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

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

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

**Text Book:**

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

Unit I: Chapter 2- Section: 12- Section 19
Unit II: Chapter 2- Section: 20, 21 and Chapter 3-Section: 23- Section: 25
Unit III: Chapter 3- Section: 26- Section 29
Unit IV: Chapter 4- Section: 30- Section 34
Unit V: Chapter 5- Section: 37, 38- Chapter 6: Section 39, 40

**Reference Books:**


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

**Semester II**

**PMTT24 OPTMIZATION TECHNIQUES 6 Hours/5 Credits**

***Objectives:***

1. *Use integer programming programming problem to solve system of linear equations.*
2. *To provide the depth knowledge about inventory control theory and make students to solve the inventory problems.*
3. *To introduce the concept of non-linear programming problems.*
4. *Using optimization techniques to solve many practical problems.*

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

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

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

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

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

**Text Books:**

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

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

**Reference Books:**


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

## Semester III

**PMTT31 COMPLEX ANALYSIS 6 Hours / 5 Credits**

***Objectives:***

- *To impart various concepts about the sequence and series, analytic functions in the complex plane.*
- *Provide deep knowledge about mapping and transformation.*
- *The learner will gain knowledge of power series of analytic function*
- *To learner will be proficient in applications of Cauchy's theorem.*

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

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

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

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

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

**Text book:**

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

**Reference Books:**


1. John B. Conway "Function of one Complex Variable" 2ndEdition,Springers International Students Edition.
2. Karunakaran, Complex Analysis, Narosa Publishing House, New Delhi, 2002.
3. R.V. Churchill & J. W. Brown, Complex Variables & Applications, Mc.Graw Hill,1990.
4. John. B. Conway, Functions of One Complex Variable, Narosa Pub. House, 2002.
5. Lars V. Ahlfors, Complex Analysis, Third Ed. McGraw-Hill Book Company, Tokyo, 1979.

**Semester III**

**PMTT32 MEASURE THEORY 6Hours/5 Credits**

***Objectives:***

1. *To introduce concepts of outer measures and integration on R.*
2. *To develop the concept of analysis in abstract situations.*
3. *Provide the relationship between Riemann and Lebesgue integral*
4. *Learner will be derive integration and derivates by using Radon-Nikodym Theorem and Fubini's Theorem*

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

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

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

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

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

**Text Book**

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

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

**Reference Books:**


1. P.R. Halmos, "Measure Theory", D.VanNostrand Company, Inc. Princeton, N.J., 1950
2. H.L.Royden "Real Analysis", Prentice Hall of India 2001 edition.
3. I.K. Rana, An Introduction to Measure and Integration, Narosa Publishing House, NewDelhi, 1999
4. D.L. Cohn, Measure Theory, Birkhauser, Switzerland, 1980,

## Semester III

**PMTT33 CLASSICAL DYNAMICS 6 Hours/5 Credits**

***Objectives***:

1. *Dynamical systems are of relatively recent origin, the concept of motion in phase-space and its geometrical depiction is simple.*
2. *Solutions find for some equations and canonical transformations*
3. *General study of Hamiltonian flows in here are treated as a special case as Jocobi.*
4. *This is following in the footsteps of Galileo and Newton.*

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

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

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

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

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

**Text Book:**

Donald T. Greenwood, **Classical Dynamics**, PHI Pvt. Ltd., New Delhi, 1985.
Unit I - Chapter: 1.1-1.5
Unit II - Chapter: 2.1-2.4
Unit III - Chapter: 3.1,3.2 and 3.4 (3.3 Omitted)
Unit IV - Chapter: 4.1-4.4
Unit V - Chapter: 5.1-5.3

**Reference Books:**

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

## Semester III

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

***Objectives:***

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

**Calculus of Variations:**

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

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

**Unit-II: Sufficient Conditions for an Extremum**

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

**Unit-III: Direct Methods in Variational Problems**

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

**Integral Equations:**

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

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

**Text Books:**

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

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

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

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

**Reference Books:**

1.S.J. Mikhlin, Linear Integral Equations (translated from Russian), Hindustan Book Agency, 1960.

2.I.N. Snedden, Mixed Boundary Value Problems in Potential Theory, North Holland, 1966.

**Semester IV**

**PMTT41 FUNCTIONAL ANALYSIS 6Hours/5 Credits**

***Objectives:***

*1. To introduce three structure theorems of Function as Hahn – Banach theorem, open mapping theorem and uniform boundedness principle from Hilbert space..*

*2. To study the finite dimensional spectrum theory.*

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

**Unit I: Banach spaces**: The definitions and some examples-Continuous linear transformations-The Hahn-Banach Theorem- The Natural imbedding of N in $N^{**}$- The Open mapping theorem-The Conjugate of an Operator.

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

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

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

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

**Text Book:**

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

Unit I: Chapter 9 Unit II: Chapter 10

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

**Reference Books:**


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

## Semester IV

**PMTT42 DIFFERENTIAL GEOMETRY 6 Hours/5 Credits**

***Objectives:***

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

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

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

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

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

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

**Text Book:**

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

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

**Reference Books:**

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

**Semester IV**

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

## RULES AND REGULATION OF THE PROJECT

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

   (i) Pure Mathematics

   (ii) Applied Mathematics

   (iii) Mathematical Application in Real Time Activities.

2. Student allotment Method will be decided by the Department Faculties(In October 2nd week)
3. They are Four Project Common Meet(In Front of All Faculty) Power point presentation

   (i). First Meet – November last week. Work done - Topic and Area will be decided (5 marks)

   (ii). Second Meet – January 1st week. Work done-25% work ( 5 marks)

   (iii). Third Meet –February 1st week, Work done -50% work(5 marks)

   (iv). Fourth Meet – March 1st week, work done -90% work(5 marks)
4. Project Record Submission – Third week of March

   Internal: 25 marks

   External: 75 marks

**Elective Papers** **6 Hours/5 Credits**

## ALGEBRAIC NUMBER THEORY

***Objectives***

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

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

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

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

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

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

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

| | |
|---|---|
| Unit I | Chapter 1 and Chapter 2 : Sections 2.1 to 2.3 |
| Unit II | Chapter 2 : Sections 2.4 to 2.9 |
| Unit III | Chapter 2 : Sections 2.10, 2.11 and Chapter 3: Sections 3.1 to 3.3 |
| Unit IV | Chapter 3 : Sections 3.4 to 3.7 and Chapter 4 |
| Unit V | Chapter 5: Sections 5.1 to 5.4. |

**Reference Books:**


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

**AUTOMATA THEORY** **6 Hours /Credits : 5**

***Objectives***

1. *To make the students to understand the nuances of Automata and Grammar.*
2. *To explain various types of automata and grammar.*
3. *To make them to understand the applications of these techniques in computer science.*
4. *To solve the sums based on automata and grammar.*

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

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

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

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

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

**Text Books:**

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

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

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

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

**References Books:**

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

## PROBABILITY THEORY AND STATISTICS

**6 Hours/ 5 Credits**

***Objectives***

1. *To learn the advanced theory of possibility and distributions and Estimations.*
2. *To understand the concepts of probability and its properties.*
3. *The learner to know constructing the probability distribution of a random variable based on the real-world situation and compute mean and variance and many distributions.*
4. *The learner identifying situations where one-way ANOVA and Latin square.*

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

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

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

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

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

**Text Books:**

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

**Reference Books:**

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

**MATLAB & LATEX** **6 Hours/5 Credits**

***Objective:***

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

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

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

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

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

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

**Text Books:**

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

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

**Reference Books:**

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

## FUZZY SETS AND THEIR APPLICATIONS 6 Hours/5Credits

***Objectives:***

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

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

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

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

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

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

**Text Books:**

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

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

**Reference Books:**

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

## NEURAL NETWORKS 6 Hours/5 Credits

***Objectives**:*

1. *To introduce the main fundamental principles and techniques of neural network systems and investigate the principal neural network models and applications.*
2. *To provide the deep knowledge on Dynamic Neural units.*
3. *To study the concepts of Continuous-time dynamic neural networks.*
4. *Specific outcome of learning: The learner will acquire in – depth knowledge of Neural Network-Applications of neural network Nonlinear models and dynamics behavior of DNN Hopfield dynamic neural network Conditions for equilibrium points in DNN.*

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

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

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

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

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

**Text Books:**

1.A. AntoSpiritusKingsly, **Neural network and fuzzy logic control**, Anuradha publications, Chennai, 2009.

2.Madan M. Gupta, Liang Jin&Noriyasu Homma, **Static and Dynamic neural networks**, A

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

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

**Reference Books:**

1.JaceK M. Zurada, Introduction to Artificial Neural Systems, Jaico Publishing House, Chennai, 2006.

2.Kevin L. Priddy& Paul E. Keller, Artificial Neural Networks, PHI Learning Private Limited, New Delhi, 2009.

3.Elaine Rich &Kevin Knight, Artificial Intelligence, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2005.

4.S. Rajasekaran& G. A. VijayalakshmiPai, Neural Networks, Fuzzy Logic and Genetic Algorithms synthesis and applications, PHI Learning Private Limited, New Delhi, 2008.

**STOCHASTIC PROCESS** **6 Hours/5 Credits**

***Objectives:***

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

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

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

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

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

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

**Text Books:**

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

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

**Reference Books:**

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

**FLUID DYNAMICS** **6 Hours/ 5 Credits**

***Objectives:***

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

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

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

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

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

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

**Text Book:**

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

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

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

Unit III: Chapter 4: 4.1 – 4.2

Unit IV: Chapter 5:5.1 – 5.4

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

**Reference Books:**


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

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

## NON LINEAR DIFFERENTIAL EQUATIONS 6 Hours/5 Credits

***Objectives:***

1. *To study Non-linear DE and its properties.*
2. *To study oscillation and stability properties of the solutions.*
3. *To provide clear knowledge about perturbation methods.*
4. *To understand the concepts of linear systems and stability.*

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

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

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

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

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

**Text Book**

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

**References**


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

**FINANCIAL MATHEMATICS** **6Hours/ 5 Credits**

***Objectives:***

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

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

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

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

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

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

**Text Book**

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

**References**


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

**CONTROL THEORY** **6 Hours/5 Credits**

***Objectives:***

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

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

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

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

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

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

**Text Book:**

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

**References Books:**

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

2.Functional Analysis and Modern Applied Mathematics by R.F.Curtain and A.J.Pritchard, Academic Press, New York, 1977.

3.Controllability of Dynamical Systems by J.Klamka, Kluwer Academic Publisher, Dordrecht, 1991

**FRACTAL ANALYSIS** **6 Hours/5 Credits**

***Objectives:***

1. *To introduce the basic mathematical techniques of fractal geometry for diverse applications.*
2. *Specific learning outcome The learner will able to understand the basic concepts of fractals and measure recognize the space of fractals and fractal dimension find the Hausdorff, box-counting and other dimensions understand the self -similar sets properties of fractals recognize the concepts fractal interpolation.*
3. *To provide the clear knowledge about fractals and measures.*
4. *To understand the concepts of the space of fractals and fractal dimensions*.

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

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

**Unit III:** Hausdorff, Box-Counting and Other Dimensions : Hausdorff Measure – Hausdorff Dimension – Calculation of Hausdorff Dimension-Simple Examples – Equivalent Definition of Hausdorff Dimension – Finer Definitions of Dimension – Box-Counting Dimensions – Properties and Problems of Box-Counting Dimension – Modified Box-Counting Dimensions – Packing Measures and Dimensions – Some Other Definitions of Dimension – Techniques for Calculating Dimensions: Basic Methods – Subsets of Finite Measure – Potential Theoretic Methods – Fourier Transform Methods.

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

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

**Text Books:**

1.Kenneth J. Falconer, **Fractal Geometry: Mathematical Foundations and Applications**, John Wiley and Sons, 2003.

2. Michael F. Barnsley, **Fractals Everywhere**, Academic Press Professional, 1988.

**Reference Books**:

1.G. A. Edgar, Measure, Topology and Fractal Geometry, Springer – New York, 2008.

2.Kenneth J. Falconer, The Geometry of Fractals Sets, Cambridge University Press, Cambridge, 1985.

3.Paul S. Addison, Fractals and Chaos: An Illustrated Course, Overseas Press, 2005.

## TENSOR ANALYSIS AND SPECIAL THEORY OF RELATIVITY

**6 Hours/ 5 Credits**

***Objectives:***

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

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

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

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

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

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

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

**Text Books:**

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

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

**Reference Books:**

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

**MATHEMATICAL BIOLOGY** **6 Hours/5Credits**

***Objectives:***

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

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

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

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

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

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

**Text Book**s:

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

Unit II- Chapter 2: 2.3-2.

Unit III- Chapter 3: 3.1-3.4

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

Vol. 129, 2013.

Unit IV- Chapter 2: 2.1-2.4

Unit V- Chapter 2: 2.5

**Reference Books:**

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

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

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