# SWAMI DAYANANDA COLLEGE OF ARTS & SCIENCE, MANJAKKUDI – 612 610.

## DEPARTMENT OF MATHEMATICS

## PROGRAMME OUTCOMES
## PROGRAMME SPECIFIC OUTCOMES
## COURSE OUTCOMES

## FOR

## M.Sc., MATHEMATICS DEGREE PROGRAMME

**BHARATHIDASAN UNIVERSITY**  **TIRUCHIRAPPALLI - 620 024**

## M.Sc. MATHEMATICS: CHOICE BASED CREDIT SYSTEM – LEARNING OUTCOMES BASED CURRICULUM FRAMEWORK (CBCS - LOCF)

**(Applicable to the candidates admitted from the academic year 2022-2023 onwards)**

| Sem | Course | Title | Ins. Hrs / Week | Credit | Exam Hrs | Marks | | Total |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Int. | Ext. | |
| I | Core Course – I (CC) | Algebra | 6 | 5 | 3 | 25 | 75 | 100 |
| | Core Course – II (CC) | Real Analysis | 6 | 5 | 3 | 25 | 75 | 100 |
| | Core Course – III (CC) | Ordinary Differential Equations | 6 | 5 | 3 | 25 | 75 | 100 |
| | Core Choice Course – I (CCC) (any one title) | 1. Classical Dynamics (or)<br>2. Automata Theory | 6 | 5 | 3 | 25 | 75 | 100 |
| | Elective Course – I (EC) | Any one from the list | 6 | 4 | 3 | 25 | 75 | 100 |
| | **TOTAL** | | **30** | **24** | | | | **500** |
| II | Core Course – IV (CC) | Complex Analysis | 6 | 5 | 3 | 25 | 75 | 100 |
| | Core Course – V (CC) | Linear Algebra | 6 | 5 | 3 | 25 | 75 | 100 |
| | Core Choice Course – II(CCC) (any one title) | 1. Partial Differential Equations (or)<br>2. Nonlinear Differential Equations | 6 | 5 | 3 | 25 | 75 | 100 |
| | Elective Course – II (EC) | Any one from the list | 6 | 4 | 3 | 25 | 75 | 100 |
| | Non-Major Elective – I (NME) | Statistics | 3 | 2 | 3 | 25 | 75 | 100 |
| | Value-Added Course – I (VAC) (any one title) | 1. Introduction to LATEX (or)<br>2. Introduction to MAT LAB | 3 | 2* | 3 | 25 | 75 | 100 |
| | **TOTAL** | | **30** | **21** | | | | **600** |

***The value added courses credit will not be included in the total CGPA. These courses are extra-credit courses.**

**Instruction hours for these courses is 30 hours.**

## LIST OF ELECTIVE COURSES

| Elective I | | Elective II | |
|---|---|---|---|
| 1 | Graph Theory | 1 | Optimization Techniques |
| 2 | Discrete Mathematics | 2 | Mathematical Modeling |
| 3 | Fuzzy Set Theory | 3 | Stochastic Processes |
| **Elective III** | | **Elective IV** | |
| 1 | Integral Equations and Calculus of Variations | 1 | Theory of Probability |
| 2 | Financial Mathematics | 2 | Tensor Analysis and Special Theory of Relativity |
| 3 | Combinatorics | 3 | Algebraic Topology |

## SUMMARY OF CURRICULUM STRUCTURE OF PG PROGRAMMES

| Sl. No. | Types of the Courses | No. of Courses | No. of Credits | Marks |
|---|---|---|---|---|
| 1. | Core Courses | 10 | 50 | 800 |
| 2. | Core Choice Courses | 3 | 15 | 300 |
| 3. | Elective Courses | 4 | 16 | 300 |
| 4. | Entrepreneurship/ Industry Based Course | 1 | 5 | 100 |
| 5. | Project | 1 | 5 | 100 |
| 6. | Non-Major Elective Courses | 2 | 4 | 200 |
| | **Total** | **21** | **90** | **2100** |
| | Value Added Courses * | 2* | 4* | 200* |

**SWAMI DAYANANDA COLLEGE OF ARTS & SCIENCE, MANJAKKUDI – 612 610.**

**DEPARTMENT OF MATHEMATICS**

**PROGRAMME OUTCOMES OF M.Sc., MATHEMATICS.**

**PO01:** Master Degree Programme in Mathematics will meet the present day needs of academic and Research, Institutions and Industries..

**PO02:** Students may acquire depth knowledge in Algebra, Analysis, Topology, Functional Analysis, Optimization Techniques and Graph Theory which will motivate the students to go for higher studies/research in Mathematics..

**PO03:** Inculcate critical thinking to carry out scientific investigation objectively without being biased with preconceived notions.

**PO04:** Prepare students for pursuing research or careers in mathematical sciences and applied fields.

**PO05:** Equip the student with skills to analyze problems, formulate a hypothesis, evaluate and validate results, and draw reasonable conclusions thereof.

**SWAMI DAYANANDA COLLEGE OF ARTS & SCIENCE, MANJAKKUDI – 612 610.**

**DEPARTMENT OF MATHEMATICS**

**PROGRAMME SPECIFIC OUTCOMES OF B.Sc., MATHEMATICS.**

**PSO01:** Mastery of Fundamental Mathematical Concepts (Algebra, Analysis, Geometry), Will gain the ability to understand and deal with abstract concepts,Communicate mathematical concepts effectively

**PSO02:** Ability to think critically and creatively

**PSO03:** Analyze and model real world problems based on mathematical principles

**PSO04:** Ability to solve problems which are modeled.

**PSO05:** Communicate the solutions in rigorous mathematical language,Ability to progress independently and ethically

PO, PSO ATTAINMENT LEVEL

HIGH LEVEL - 3, MODERATE LEVEL - 2, LOW LEVEL - 1

**First Year** **CORE COURSE I** **Semester: I**

**ALGEBRA**

**Code:** **(Theory)** **Credit: 5**

**OBJECTIVES:**

- To give foundation in Algebraic structures like Groups ,Rings
- To train the students in problem solving in Algebra

**UNIT – I:**

Set Theory – Mappings – Group – Subgroups – A counting Principle - Normal Subgroups and Quotient groups.

**UNIT – II:**

Homomorphism – Cayley's theorem – Permutation groups – Another counting principle – Sylow's theorems.

**UNIT – III:**

Homomorphisms -Ideals and quotient rings – More ideals and quotient rings – Euclidean Rings-A particular Euclidean Ring.

**UNIT – IV:**

Polynomial rings – Polynomials over the rational field – polynomials over commutative Rings -Inner Product spaces.

**UNIT – V:**

**FIELDS**: Extension fields – Roots of Polynomials – More about roots – The elements of Galois theory– Finite fields.

**UNIT – VI CURRENT CONTOUR (For Continuous Internal Assessment Only):**

Classification of finite Groups - Commutative rings, Applications of field theory to coding theory.

**REFERENCES:**


1. I.N. Herstein, Topics in Algebra, Second Edn, Wiley Eastern Limited.
   UNIT – I - Chapter 1: Sec 1.1, 1.2 Chapter 2: Sec 2.1 – 2.6
   UNIT – II - Chapter 2: Sec 2.7, 2.9, 2.10, 2.11, 2.12
   UNIT – III - Chapter 3: Sec 3.3, 3.4, 3.5, 3.7, 3.8.
   UNIT – IV - Chapter 3: 3.9, 3.10, 3.11 Chapter 4: 4.4
   UNIT – V - Chapter 5: Sec 5.1, 5.3, 5.5, 5.6 Chapter 7: Sec 7.1
2. David S. Dummit and Richard M. Foote, Abstract Algebra, Third Edition, Wiley Student Edition, 2015.
3. John, B. Fraleigh, A First Course in Abstract Algebra, Addison-Wesley Publishing Company.

4. Vijay, K. Khanna, and S.K. Bhambri, A Course in Abstract Algebra, Vikas Publishing House Pvt Limited, 1993.
5. Joseph A. Gallian, Contemporary Abstract Algebra, Fourth Edition, Narosa publishing House, 1999.
6. http://www.math.stonybrook.edu/~irwin/algbk.pdf
7. https://www.math.usm.edu/perry/old_classes/mat423fa11/notes_25aug2011.pdf

| Semester: I | Core Course : I | Algebra | Credit : 5 | Allotted hours per week: 6 |
|---|---|---|---|---|

**CO01:** Gain expertise in the basic concepts of group theory with the help of numerous examples.Discuss in detail about permutation groups and Normal subgroups and discuss on counting tricks in algebra.

**CO02:** Bring out the key steps involved in proving Sylow theorems and use Sylow's theorems to classify groups of finite order upto 120.

**CO03:** Learn the fundamental concept in field theory of field extensions and would see the idea of generating new fields.

**CO04:** Have clear cut idea in the notions of Galois groups, normal extensions and separable extensions and illustrate them with various examples.

**CO05:** Able to understand the Fundamental theorem of Galois theory.

**PSO-PO-CO MAPPING MATRIX**

| PO & PSO / CO | PO01 | PO02 | PO03 | PO04 | PO05 | PSO01 | PSO02 | PSO03 | PSO04 | PSO05 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO01 | 3 | 1 | 1 | 1 | 2 | 3 | 2 | 2 | 1 | 2 |
| CO02 | 1 | 2 | 3 | 1 | 1 | 1 | 2 | 3 | 2 | 2 |
| CO03 | 2 | 3 | 1 | 1 | 1 | 2 | 3 | 1 | 2 | 2 |
| CO04 | 1 | 1 | 2 | 3 | 1 | 2 | 2 | 2 | 3 | 1 |
| CO05 | 1 | 1 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 2 |

| First Year | CORE COURSE II<br>REAL ANALYSIS | Semester: I |
|---|---|---|
| Code: | (Theory) | Credit: 5 |

**COURSE OBJECTIVES:**

- To enable the students to learn the basic concepts of Real Analysis and techniques in Analysis to prepare for the advanced courses like Functional Analysis and Advanced Analysis.

**UNIT – I:**

The Real and Complex Number Systems: Introduction – Ordered sets – Fields–The Real Field – Extended Real Number system–The Complex Field – Euclidean Spaces. Basic topology: Finite, countable and uncountable sets – Metric Spaces – Compact sets – Perfect sets – Connected sets.

**UNIT – II:**

Numerical Sequences: Convergent Sequences – Sub-sequences – Cauchy Sequences – Upper and Lower Limits – Some Special Sequences – Series– Series of Non-Negative Terms. Numerical Series: The Number e – The Root and Ratio Test – Power Series – Summation by Parts – Absolute Convergence- Addition and Multiplication of Series - Rearrangements.

**UNIT – III:**

Continuity: Limits of Functions - Continuous Functions – Continuity and Compactness – Continuity and Connectedness – Discontinuities – Monotonic Functions – Infinite Limits and Limits at Infinity. Differentiation: The Derivative of a Real Function – Mean Value Theorems – The Continuity of Derivatives – L'Hospital's Rule – Derivatives of Higher Order – Taylor's Theorem – Differentiation of Vector Valued Functions.

**UNIT – IV:**

The Riemann-Stieltjes Integral: Definition and existence of the integral – Properties of the Integral – Integration and Differentiation – Integration and vector valued functions – Rectifiable curves.

**UNIT – V:**

Sequence and Series of Functions: Sequence of Functions – Discussion of Main Problem–Uniform Convergence and Continuity –Uniform Convergence and Integration – Uniform Convergence and Differentiation. Families of Functions: Equi continuous Families of Functions – The Stone – Weierstrass Theorem.

**UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):**

Generalizations to topological spaces, Calculus on Manifolds.

**REFERENCES:**


1. Walter Rudin, Principles of Mathematical Analysis, 3rd Edition Tata McGraw-Hill 1985.
   UNIT – I - Chapter 1: Sec 1.1 – 1.38 & Chapter 2: Sec 2.1 – 2.47UNIT – II- Chapter 3: Sec 3.1 – 3.55
   UNIT – III - Chapter 4: Sec 4.1 – 4.34Chapter 5: Sec 5.1 – 5.19UNIT – IV - Chapter 6: Sec 6.1 – 6.27
   UNIT – V - Chapter 7: Sec 7.1 – 7.33
2. Tom. M. Apostol, Mathematical Analysis, Narosa Publishing House, NewDelhi, 1997.
3. R. G. Bartle, D. R. Sherbert, Introduction to Real Analysis, John Wiley andSons, New York, 1982.
4. Kenneth A. Ross, Elementary Analysis: The Theory of Calculus, SpringerNewYork, 2004.
5. N. L.Carothers, Real Analysis, Cambridge University Press, UK, 2000.
6. S. C. Malik, Mathematical Analysis,Willey Eastern Ltd, NewDelhi, 1985.
7. K. R. Stromberg, An Introduction to Classical Real Analysis, Wadsworth, 1981.
8. H. L. Royden, Real Analysis, Third Edition, Macmillan Publishing Company,New Delhi, 1988.
9. https://s2pnd-matematika.fkip.unpatti.ac.id/wp-content/uploads/2019/03/Real-Analysis-4th-Ed-Royden.pdf
10. http://www.freebookcentre.net/maths-books- download/gotoweb.php?id=9633

| Semester: I | Core Course : II | Real Analysis | Credit : 5 | Allotted hours per week: 6 |
|---|---|---|---|---|

**CO01:** Describe fundamental properties of the real numbers that lead to the formal development of real analysis.

**CO02:** Demonstrate an understanding of limits ad how that are used in sequences.

**CO03:** Demonstrate an understanding of limits ad how that are used in series.

**CO04:** Demonstrate an understanding of limits ad how that are used in sequences Examine and recognize the continuity of real functions.

**CO05:** Demonstrate an intuitive and computational understanding of set theory, Continuity and solving application problems. This will be assessed through homework, class quizzes and tests, and a final exam.

**PSO-PO-CO MAPPING MATRIX**

| PO & PSO / CO | PO01 | PO02 | PO03 | PO04 | PO05 | PSO01 | PSO02 | PSO03 | PSO04 | PSO05 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO01 | 1 | 3 | 3 | 1 | 2 | 3 | 2 | 2 | 2 | 3 |
| CO02 | 1 | 2 | 3 | 2 | 1 | 2 | 1 | 3 | 2 | 1 |
| CO03 | 2 | 1 | 3 | 1 | 1 | 3 | 3 | 1 | 2 | 3 |
| CO04 | 1 | 2 | 3 | 1 | 1 | 1 | 1 | 3 | 1 | 2 |
| CO05 | 1 | 1 | 3 | 2 | 1 | 3 | 2 | 2 | 3 | 2 |

**First Year** **CORE COURSE III** **Semester: I**

**ORDINARY DIFFERENTIAL EQUATIONS**

**Code:** **(Theory)** **Credit: 5**

**COURSE OBJECTIVES:**

- To give an in-depth knowledge of differential equations and their applications.
- To study the existence, uniqueness, stability behavior of the solutions of the ODE.

**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:**

Nonlinear equations: Autonomous Systems; the phase plane and its phenomena – Types of critical points; Stability – critical points and stability for linear systems – Stability by Liapunov's direct method – Simple critical points of nonlinear systems.

**UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):**

System of ode and using Canonical forms to solve.

**REFERENCES:**


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, 38 and Chapter 11: Sections 55, 56UNIT – IV- Chapter 4: Sections 22 to 24
   UNIT – V - Chapter 8: Sections 42 to 44
2. W.T. Reid, Ordinary Differential Equations, John Wiley & Sons, New York,1971.
3. E.A. Coddingtonand N. Levinson, Theory of Ordinary Differential Equaitons,McGraw Hill Publishing Company, New York, 1955.
4. http://www.freebookcentre.net/maths-books- download/gotoweb.php?id=8714
5. https://s3.amazonaws.com/open-bookshelf-content/Open+Textbook+Library/URI/urn%3Auuid%3Ae46a68f9-3e84-4999- b9f6-18c3dfb2faca/Ordinary+Differential+Equations.pdf


| Semester: II | Core Course : III | Ordinary Differential Equations | Credit : 5 | Allotted hours per week: 6 |
|---|---|---|---|---|

**CO01:** Find the general solution of the first order linear homogeneous equations.Understand the utility of the theory of power series which is studied in Real Analysis course through solving various second order differential equations.

**CO02:** Get introduced to the Hyper geometric functions which arises in connection with solutions of the second order ordinary differential equations with regular singular points. Solve the problems arises in Mathematical physics using properties of special functions.

**CO03:** Understand the importance of studying well-posedness of the problem namely existence, uniqueness and continuous dependence of first order differential equations through Picard's theorem.

**CO04:** Understand the utility of the concepts from linear algebra and analysis in the study of system of first order equations.

**CO05:** Discuss the Qualitative properties of solutions of first and second order equations. Also they will be able to work on numerous problems using comparison theorem in Sturm Liouville problems. Learn the nature of solutions which involves critical points and phase portrait of nonlinear equations.

| PSO-PO-CO MAPPING MATRIX | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **PO & PSO** | **PO01** | **PO02** | **PO03** | **PO04** | **PO05** | **PSO01** | **PSO02** | **PSO03** | **PSO04** | **PSO05** |

| CO | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| CO01 | 3 | 2 | 1 | 1 | 2 | 1 | 3 | 2 | 3 | 2 |
| CO02 | 3 | 1 | 2 | 1 | 1 | 3 | 2 | 2 | 1 | 3 |
| CO03 | 3 | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 3 | 2 |
| CO04 | 3 | 2 | 1 | 1 | 3 | 3 | 3 | 2 | 2 | 1 |
| CO05 | 3 | 1 | 2 | 1 | 1 | 2 | 3 | 2 | 2 | 3 |

**First Year** **CORE CHOICE COURSE I** **Semester: I**

**1) CLASSICAL DYNAMICS**

**Code:** **(Theory)** **Credit: 5**

**COURSE OBJECTIVES:**

- To give a detailed knowledge of the mechanical system of particles.
- To study the applications of Lagrange's and Hamilton's equations.

**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 - Small oscillations.

**UNIT – III:**

Special Applications of Lagrange's Equations: Rayleigh's dissipation function - impulsive motion - Gyroscopic systems - velocity dependent potentials.

**UNIT – IV:**

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

**UNIT – V:**

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

**UNIT – VI: CURRENT CONTOURS (For Continuous Internal Assessment Only):**

Introduction to relativity

**REFERENCES:**


1. Donald T. Greenwood, Classical Dynamics, PHI Pvt. Ltd., New Delhi-1985.
   UNIT – I - Chapter 1: Sections 1.1-1.5
   UNIT – II - Chapter 2: Sections 2.1-2.4
   UNIT – III - Chapter 3: Sections 3.1-3.4
   UNIT – IV - Chapter 4: Sections 4.1-4.4
   UNIT – V - Chapter 5: Sections 5.1-5.3
2. H. Goldstein, Classical Mechanics, (2nd Edition), Narosa Publishing House, New Delhi.
3. Narayan Chandra Rana&PromodSharad Chandra Joag, Classical Mechanics,

Tata Mc Graw Hill, 1991.

4. https://www.pdfdrive.com/download.pdf?id=158582740&h=933106dae8af21f34ec9c7549706b1ed&u=cache&ext=pdf

5. https://www.pdfdrive.com/download.pdf?id=33509812&h=f116b9421b66220f909db64ed8661069&u=cache&ext=pdf

| Semester: I | Core Choice Course : I | Classical Dynamics | Credit : 5 | Allotted hours per week: 6 |
|---|---|---|---|---|

**CO01:** Understand the important definitions and introductory concepts like the ideas of virtual work and d'Alembert's principle. Derive Lagrange's equations of motion using d'Alembert's principle.

**CO02:** Understand the nature of equations of motion for holonomic and nonholonomic systems.Understand the idea of impulsive constraints

**CO03:** Compare dissipative systems and velocity dependent potentials.Understand the Hamiltonian view point of dynamics in canonical equations of motion and phase space.

**CO04:** Understand the concepts of Hamilton - Jacobi theory.

**CO05:** Obtain some concrete procedure for solving problems using the theory of canonical transformations.

**PSO-PO-CO MAPPING MATRIX**

| PO & PSO / CO | PO01 | PO02 | PO03 | PO04 | PO05 | PSO01 | PSO02 | PSO03 | PSO04 | PSO05 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO01 | 2 | 3 | 1 | 1 | 2 | 1 | 3 | 2 | 2 | 3 |
| CO02 | 1 | 3 | 2 | 1 | 1 | 3 | 2 | 2 | 3 | 2 |
| CO03 | 2 | 3 | 1 | 1 | 2 | 2 | 3 | 1 | 2 | 3 |
| CO04 | 2 | 3 | 1 | 3 | 1 | 2 | 2 | 3 | 2 | 3 |
| CO05 | 1 | 3 | 2 | 1 | 2 | 3 | 2 | 2 | 2 | 1 |

**First Year** **ELECTIVE COURSE I** **Semester: I**

**1) GRAPH THEORY**

**Code:** **(Theory)** **Credit: 4**

**COURSE OBJECTIVES:**

- To give a rigorous study of the basic concepts of Graph Theory.
- To study the applications of Graph Theory in other disciplines.

**Note:** Theorems, Propositions and results which are starred are to be omitted.

**UNIT – I:**

Basic Results: Basic Concepts - Subgraphs - Degrees of Vertices - Paths and Connectedness- Operations on Graphs - Directed Graphs: Basic Concepts – Tournaments.

**UNIT – II:**

Connectivity: Vertex Cuts and Edge Cuts - Connectivity and Edge - Connectivity, Trees: Definitions, Characterization and Simple Properties - Counting the Number of Spanning Trees - Cayley's Formula.

**UNIT – III:**

Independent Sets and Matchings: Vertex Independent Sets and Vertex Coverings - Edge Independent Sets -Matchings and Factors - Eulerian Graphs - Hamiltonian Graphs.

**UNIT – IV:**

Graph Colourings: Vertex Colouring - Critical Graphs - Triangle - Free Graphs - Edge Colouringsof Graphs - Chromatic Polynomials.

**UNIT – V:**

Planarity: Planar and Nonplanar Graphs - Euler Formula and its Consequences - K5 and K3,3 are Nonplanar Graphs - Dual of a Plane Graph - The Four-Colour Theorem and the Heawood Five-Colour Theorem-Kuratowski's Theorem.

**UNIT – VI: CURRENT CONTOURS (For Continuous Internal Assessment Only):**

The Four Color Conjecture

**TEXT BOOK(S):**

1. R. Balakrishnan, K. Ranganathan, A Textbook of Graph Theory, Springer International Edition, New Delhi, 2008.
   UNIT I - Chapter I & II: 1.1 to 1.4, 1.7, 2.1, 2.2
   UNIT II - Chapter III & IV: 3.1, 3.2, 4.1, 4.3 to 4.4

UNIT III - Chapter V & VI: 5.1 to 5.4, 6.1, 6.2

UNIT IV - Chapter VII: 7.1 to 7.4, 7.7

UNIT V - Chapter VIII: 8.1 to 8.6


2. J.A. Bondy, U.S.R. Murty, Graph Theory with Applications, Mac MilanPress Ltd., 1976.
3. Gary Chartrand, Linda Lesniak, Ping Zhang, Graphs and Digraph,CRC press,2010.
4. F.Harary, Graph Theory, Addison - Wesley, Reading, Mass., 1969.
5. https://www.whitman.edu/mathematics/cgt_online/cgt.pdf
6. https://www.pdfdrive.com/download.pdf?id=188461519&h=0e27445c1a90d11918eeab7108536b09&u=cache&ext=pdf


| Semester: I | Elective Course : I | Graph Theory | Credit : 4 | Allotted hours per week: 6 |
|---|---|---|---|---|

**CO01:** Understand and work on the fundamental concepts of graphs.

**CO02:** Apply graph theory based tools in solving practical problems.

**CO03:** Understand basic concepts in Trees

**CO04:** Discuss matching problems and its applications elsewhere.

**CO05:** Comprehend and work on the concepts of planarity and discuss the dual of a plane graph.

**PSO-PO-CO MAPPING MATRIX**

| PO & PSO / CO | PO01 | PO02 | PO03 | PO04 | PO05 | PSO01 | PSO02 | PSO03 | PSO04 | PSO05 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO01 | 1 | 3 | 2 | 1 | 2 | 3 | 1 | 2 | 2 | 3 |
| CO02 | 1 | 2 | 3 | 1 | 1 | 2 | 3 | 3 | 2 | 2 |
| CO03 | 1 | 3 | 1 | 2 | 2 | 1 | 3 | 1 | 1 | 2 |
| CO04 | 1 | 2 | 1 | 3 | 1 | 2 | 2 | 2 | 3 | 1 |
| CO05 | 1 | 2 | 1 | 3 | 1 | 3 | 2 | 3 | 2 | 1 |

**First Year** **CORE COURSE IV** **Semester: II**

**COMPLEX ANALYSIS**

**Code:** **(Theory)** **Credit: 5**

**COURSE OBJECTIVES:**

- To learn the various intrinsic concepts and the theory of Complex Analysis.
- To study the concept of Analyticity, Complex Integration and Infinite Products in depth.

**UNIT – I:**

Elementary Point Set Topology: Sets and Elements – Metric Spaces – Connectedness – Compactness – Continuous Functions – Topological Spaces; Conformality: Arcs and Closed Curves – Analytic Functions in Regions – Conformal Mapping – Length and Area; Linear Transformations: The Linear Group – The Cross Ratio – Symmetry.

**UNIT – II:**

Fundamental theorems in complex integration: 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.

**UNIT – III:**

Local Properties of Analytic Functions - Removable Singularities - Taylor's Theorem – Integral representation of the nth term - Zeros and Poles – Algebraic order of f(z) – Essential Singularity - The Local Mapping – The Open Mapping Theorem - The Maximum Principle.

**UNIT – IV:**

The General Form of Cauchy's Theorem: Chains and Cycles – Simple Connectivity – Homology – The General Statement of Cauchy's Theorem – Proof of Cauchy's Theorem – Locally Exact Differentials – Multiply Connected Regions; The Calculus of Residues: The Residue Theorem – The Argument Principle – Evaluation of Definite Integrals.

**UNIT – V:**

Harmonic Functions: Definition and Basic Properties – The Mean-value Property – Poisson's Formula – Schwarz's Theorem – The Reflection Principle; Power series expansions-Weierstrass's Theorem – The Taylor Series – The Laurent Series.

**UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):**

Analytic Continuation - Global version of Cauchy's theorem

**REFERENCES:**


1. Lars V. Ahlfors, Complex Analysis, Third Ed. McGraw-Hill Book Company,Tokyo, 1979.
   UNIT – I - Chapter 3: 1.1-1.6, 2.1-2.4,3.1-3.3
   UNIT – II - Chapter 4: 1.1-1.5, 2.1-2.3
   UNIT – III - Chapter 4: 3.1, 3.2, 3.3,3.4
   UNIT – IV - Chapter 4: 4.1-4.7, 5.1-5.3
   UNIT – V - Chapter 4: 6.1-6.5 and Chapter 5: 1.1-1.3
2. Serge Lang, Complex Analysis, Addison Wesley, 1977.
3. S. Ponnusamy, Foundations of Complex Analysis, Narosa Publishing House,NewDelhi, 1997.
4. Karunakaran, Complex Analysis, Alpha Science international Ltd,Second

edition, 2005.
5. https://s2pnd-matematika.fkip.unpatti.ac.id/wp-content/uploads/2019/03/John-M.-Howie-Complex-Analysis-Springer-Undergraduate-Mathematics-Series-Springer-2007.pdf
6. https://mccuan.math.gatech.edu/courses/6321/lars-ahlfors-complex- analysis-third-edition-mcgraw-hill-science engineering math-1979.pdf

| Semester: II | Core Course : IV | Complex Analysis | Credit : 5 | Allotted hours per week: 6 |
|---|---|---|---|---|

**CO01:** Understand the complex number system from geometric view point. Will gain mastery in arguments on C* and logarithms.

**CO02:** Get expertise in the concept of convergence of sequences and series of complex numbers, continuity and differentiability of function on complex numbers. Also the students will be able to thoroughly understand and know the importance of power series in complex analysis.

**CO03:** Workout the path integrals on the complex plane. Understand the central theme of Cauchy theory, viz., existence of local primitives and local power series expansion.

**CO04:** Get acquainted with various techniques of proving fundamental theorem of algebra, open mapping theorem, maximum modulus theorem and Liouville's theorem.

**CO05:** Classify singularities, compute poles and residues and understand the Laurent series expansion. Appreciate and work on the topology of extended complex plane.

**PSO-PO-CO MAPPING MATRIX**

| PO & PSO / CO | PO01 | PO02 | PO03 | PO04 | PO05 | PSO01 | PSO02 | PSO03 | PSO04 | PSO05 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO01 | 3 | 1 | 2 | 1 | 1 | 3 | 2 | 3 | 1 | 2 |
| CO02 | 2 | 3 | 1 | 1 | 1 | 1 | 3 | 2 | 3 | 1 |
| CO03 | 2 | 1 | 1 | 3 | 1 | 2 | 3 | 1 | 2 | 2 |
| CO04 | 1 | 1 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 3 |
| CO05 | 2 | 1 | 1 | 3 | 1 | 2 | 3 | 2 | 3 | 2 |

| First Year | CORE COURSE V<br>LINEAR ALGEBRA | Semester: II |
|---|---|---|
| Code: | (Theory) | Credit: 5 |

**COURSE OBJECTIVES:**

- To give the students a thorough knowledge of the various aspects of Linear Algebra
- To train the students in problem-solving as a preparatory for competitive exam.

**UNIT – I:**

Matrices: Systems of linear Equations - Matrices and Elementary Row operations -Row-reduced echelon Matrices - Matrix Multiplication - Invertible Matrices-Bases and Dimension. (Only revision of Vector spaces and subspaces).

**UNIT – II:**

Linear transformations: The algebra of linear transformations - Isomorphism of Vector Spaces -Representations of Linear Transformations by Matrices - Linear Functionals - The Double Dual - The Transpose of a Linear Transformation.

**UNIT – III:**

Algebra of polynomials: The algebra of polynomials - Lagrange Interpolation - Polynomial Ideals -The prime factorization of a polynomial - Commutative rings – Determinant functions.

**UNIT – IV:**

Determinants: Permutations and the uniqueness of determinants - Classical Adjoint of a (square) matrix - Inverse of an invertible matrix using determinants - Characteristic values - Annihilating polynomials.

**UNIT – V:**

Diagonalization: Invariant subspaces - Simultaneous triangulation and simultaneous Diagonalization Direct-sum Decompositions - Invariant Direct sums – Primary Decomposition theorem.

**UNIT – VI: CURRENT CONTOURS (For Continuous Internal Assessment Only):**

Introduction to Module theory

**REFERENCES:**

1. Kenneth Hoffman and Ray Alden Kunze, Linear Algebra, Second Edition, Prentice Hall of India Private Limited, New Delhi, 1975.
   UNIT – I - Chapter 1 & 2 1.2-1.6 and 2.3
   UNIT – II - Chapter 3
   UNIT – III - Chapter 4 & 5 4.1 - 4.5 and 5.1 - 5.2
   UNIT – IV - Chapter 5 & 6 5.3, 5.4 and 6.1 - 6.3

UNIT – V - Chapter 6 6.4 - 6.8
2. S. Kumaresan, Linear Algebra: A Geometric Approach, Prentice-Hall of IndiaLtd, 2004.
3. V. Krishnamurthy, V.P. Mainra, J.L. Arora, Introduction to LinearAlgebra,East West Press Ltd, 1985.
4. A.R. Rao, P. Bhimashankaram, Linear Algebra, Second Edition, Tata McGrawHill, 2000.
5. Edgar G.Goodaire,Linear Algebra-Pure & Applied World Scientific,CambridgeUniversity Press India Ltd, 2014.
6. https://joshua.smcvt.edu/linearalgebra/book.pdf
7. https://resources.saylor.org/wwwresources/archived/site/wp-content/uploads/2012/02/Linear-Algebra-Kuttler-1-30-11-OTC.pdf

| Semester: II | Core Course : V | Linear Algebra | Credit :5 | Allotted hours per week: 6 |
|---|---|---|---|---|

**CO01:** Realise that the subject evolves as a generalization of solving a system of linear equations. Discuss in detail the basic concepts of Linear dependence, basis and dimension of a vector space. The students will be able to demonstrate how the geometric ideas turn into rigorous proofs.

**CO02:** Master the dimension formula and rank and nullity theorem which are often exploited. Capture the idea of producing lot of structure preserving maps (Linear transformations). Further the study of algebras of linear maps would be accomplished.

**CO03:** Having got trained in numerous examples the student realizes the isomorphic theory of linear transformations and matrices. Learn the theory of determinants and put them in practice.

**CO04:** Understand that the central theme of structure theory of linear maps is to decompose the given vector space as a direct sum of generalized the Eigen spaces using the given map on it.

**CO05:** Understand that linear Algebra plays a fundamental role in many areas of mathematics including Algebra, Geometry, Functional analysis and which finds widest application in Physics, Chemistry and elsewhere.

**PSO-PO-CO MAPPING MATRIX**

| PO & PSO / CO | PO01 | PO02 | PO03 | PO04 | PO05 | PSO01 | PSO02 | PSO03 | PSO04 | PSO05 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO01 | 3 | 1 | 2 | 1 | 1 | 3 | 2 | 2 | 1 | 2 |
| CO02 | 1 | 3 | 1 | 1 | 2 | 2 | 1 | 3 | 2 | 3 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO03** | **1** | **2** | **1** | **3** | **1** | **3** | **2** | **2** | **1** | **2** |
| **CO04** | **2** | **1** | **3** | **1** | **3** | **1** | **2** | **3** | **2** | **2** |
| **CO05** | **1** | **2** | **1** | **3** | **1** | **2** | **3** | **2** | **1** | **3** |

**First Year** **CORE CHOICE COURSE II** **Semester: II**

**1) PARTIAL DIFFERENTIAL EQUATIONS**

**Code:** **(Theory)** **Credit: 5**

**COURSE OBJECTIVES:**

- To give an in-depth knowledge of solving partial differential equations and apply them in scientific and engineering problems.
- To study the other aspects of PDE.

**UNIT – I:**

Partial differential equations- origins of first order Partial differential equations- Cauchy's problem for first order equations- Linear equations of the first order- Integral surfaces Passing through a Given curve- surfaces Orthogonal to a given system of surfaces -Nonlinear Partial differential equations of the first order.

**UNIT – II:**

Cauchy's method of characteristics- compatible systems of first order equations- Charpits method- Special types of first order equations- Solutions satisfying given conditions- Jacobi's method.

**UNIT – III:**

Partial differential equations of the second order: The origin of second order equations –second order equations in Physics – Higher order equations in Physics - Linear partial differential equations with constant co-efficient- Equations with variable coefficients-Characteristic curves of second order equations.

**UNIT – IV:**

Characteristics of equations in three variables- The solution of Linear Hyperbolic equations-Separation of variables.The method of Integral Transforms – Non Linear equations of the second order.

**UNIT – V:**

Laplace equation: Elementary solutions of Laplace's equations-Families of equipotential Surfaces- Boundary value problems-Separation of variables – Problems with Axial Symmetry.

**UNIT – VI: CURRENT CONTOURS (For Continuous Internal Assessment Only):**

Greens function - Theory of distributions.

**REFERENCES:**

1. Ian N. Sneddon,Elements of Partial differential equations, Dover Publication – INC, New York, 2006.

UNIT – I - Chapter II Sections 1 to 7

UNIT – II - Chapter II Sections 8 to 13 UNIT – III - Chapter III Sections 1 to 6 UNIT – IV - Chapter III Sections 7 to 11UNIT – V - Chapter IV Sections 2 to 6


2. M.D. Raisinghania, Advanced Differential Equations, S. Chand and companyLtd., New Delhi,2001.
3. E.T. Copson, Partial Differential Equations, Cambridge University Press.
4. https://s2pnd-matematika.fkip.unpatti.ac.id/wp-content/uploads/2019/03/Walter-A-Strauss-Partial-differential-equations- -an-introduction-Wiley-2009.pdf
5. http://web.math.ucsb.edu/~moore/pde.pdf


| Semester: II | Core Choice Course : II | Partial Differential Equations | Credit : 5 | Allotted hours per week: 6 |
|---|---|---|---|---|

**CO01:** Classify first order partial differential equations and their solutions.Solve first order equations and nonlinear partial differential equations using various methods.

**CO02:** Use the method of characteristics to solve first order partial differential equations.

**CO03:** Identify and solve the three main classes of second order equations, elliptic, parabolic and hyperbolic

**CO04:** Solve one dimensional wave equations using methodof separation of variables. Classify the boundary value problems and analyse its solutions.

**CO05:** Solve Heat conduction problem using Fourier series and cosines. Illustrate the use of PDE in problems from Engineering and Biological Sciences.

**PSO-PO-CO MAPPING MATRIX**

| PO & PSO / CO | PO01 | PO02 | PO03 | PO04 | PO05 | PSO01 | PSO02 | PSO03 | PSO04 | PSO05 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO01 | 3 | 1 | 1 | 1 | 2 | 2 | 2 | 3 | 1 | 3 |
| CO02 | 1 | 1 | 2 | 1 | 3 | 3 | 1 | 2 | 2 | 1 |
| CO03 | 1 | 3 | 1 | 1 | 2 | 2 | 3 | 1 | 3 | 2 |
| CO04 | 1 | 1 | 3 | 1 | 2 | 1 | 2 | 3 | 2 | 3 |
| CO05 | 1 | 1 | 1 | 2 | 3 | 2 | 3 | 2 | 1 | 3 |

**First Year** **ELECTIVE COURSE II** **Semester: II**

**1) OPTIMIZATION TECHNIQUES**

**Code:** **(Theory)** **Credit: 4**

**COURSE OBJECTIVES:**

- To provide insights into structures and processors that operations research can offer and the enormous practical utility of its various techniques.
- To explain the concepts and simultaneously to develop an understanding of problem solving methods based upon model formulation, solution procedures and analysis.

**UNIT – I:**

Linear Programming Problem – Pure and Mixed Integer Programming Problems – Gromory's All I.P.P. Method – Construction of Gomory's Constraints - Fractional Cut Method-All Integer LPP – Fractional Cut Method-Mixed Integer LPP – Branch and Bound Method – Applications of Integer Programming.

**UNIT – II:**

Dynamic Programming – The Recursive Equation Approach – Characteristics of Dynamic Programming – Dynamic Programming Algorithm – Solution of Discrete DPP – Applications – Solution of LPP by Dynamic Programming.

**UNIT – III:**

Goal Programming – Categorisation of Goal Programming – Formulation of Linear Goal Programming Problem – Graphical Goal Attainment Method – Simplex Method for Goal Programming Problem.

**UNIT – IV:**

Non-Linear Programming - Formulation - constrained optimization - with equalingconstraints, with in-equaling constraints - saddle point problems.

**UNIT – V:**

Non-Linear Programming problems Methods - Graphical sign - Kuhn-Tucker conditions with non- negative constrains - quadratic programming - Wolfe's modified simplex method - Beale's method - separable convex programming - separable programming Algorithm.

**UNIT – VI: CURRENT CONTOURS (For Continuous Internal Assessment Only):**

Solving problems using PYTHON Programming

**REFERENCES:**

1. KantiSwarup, P.K. Gupta, Man Mohan, Operations Research, Sultan Chand & sons, New Delhi, 2019.

UNIT – I Chapter
7 UNIT – II Chapter
13UNIT – III Chapter
8 UNIT – IV Chapter
27UNIT – V Chapter
28

2. Hamdy A. Taha, Operations Research (10th Edn.), McGraw Hill Publications,New Delhi.2019.
3. Bazaara, Jarvis and Sherali, Linear Programming and Network Flows, 4thed., John Wiley, 2010
4. O.L. Mangasarian, Non Linear Programming, McGraw Hill, New York, 1994.
5. Mokther S. Bazaraa and C.M. Shetty, Non Linear Programming, Theory andAlgorithms, 3rd edn, Willy, New York, 2013.
6. Prem Kumar Gupta and D.S. Hira, Operations Research: An Introduction, S.Chand and Co., Ltd. New Delhi, 2014.
7. S.S. Rao, Optimization Theory and Applications, 4th edn, Wiley, 2009.
8. G. Hadley, Linear Programming, Narosa Publishing House, 2002
9. http://www.ru.ac.bd/stat/wp-content/uploads/sites/25/2019/03/405_01_Srinivasan_Operations- Research_-Principles-and-Applications-Prentice-Hall-of-India-2010.pdf
10. https://www.bbau.ac.in/dept/UIET/EME- 601%20Operation%20Research.pdf

| Semester:II | Elective Course : II | Optimization Techniques (Theory) | Credit : 4 | Allotted hours per week: 6 |
|---|---|---|---|---|

**CO01:** Do mathematical formulation of a real life problem into a linear programming problem.

**CO02:** Solve linear programming problem using graphical method and simplex method.

**CO03:** Understand Integer programming problem. Find solutions to linear programming problem by dynamic programming.

**CO04:** Understand the concepts of nonlinear programming problems.

**CO05:** Solve nonlinear programming problems using Wolfe's method and Beale's method.

| PSO-PO-CO MAPPING MATRIX | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| PO & PSO | PO01 | PO02 | PO03 | PO04 | PO05 | PSO01 | PSO02 | PSO03 | PSO04 | PSO05 |

| CO | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| CO01 | 3 | 1 | 2 | 1 | 1 | 2 | 1 | 2 | 2 | 3 |
| CO02 | 1 | 2 | 1 | 3 | 1 | 2 | 3 | 2 | 2 | 1 |
| CO03 | 2 | 1 | 3 | 1 | 1 | 2 | 2 | 2 | 1 | 2 |
| CO04 | 1 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 3 | 2 |
| CO05 | 1 | 3 | 1 | 2 | 1 | 3 | 2 | 1 | 2 | 3 |

**First Year** **VALUE ADDED COURSE I** **Semester: II**

**1) INTRODUCTION TO LATEX**

**Code:** **(Theory)** **Credit: *2**

**COURSE OBJECTIVES:**

- To make the students learn the art of typing mathematics text on their own.
- To inculcate professional training required to become a scholar in mathematics.

**UNIT – I:**

Basic Structure of Latex 2e - Input file structure - Layout -Editors - ForwardSearch- Inverse Search - Compiling - Conversion to various formats.

**UNIT – II:**

Typesetting simple documents - sectioning - Titles- page layout -listing – enumerating - quote - letter formats.

**UNIT – III:**

Using package amsmath typing equations labeling and referring.

**UNIT – IV:**

Figure inclusion - Table inclusion.

**UNIT – V:**

Bibliography - Index typing - Beamer presentation Styles.

**UNIT – VI: CURRENT CONTOURS (For Continuous Internal Assessment Only):**Type a mathematical article using various journal style files

**REFERENCES:**


1. Leslie Lamport. LATEX: A Document Preparation System, Addison-Wesley, Reading, Massachusetts, second edition, 1994.
2. Tobias Oetiker, Hubert Partl, Irene Hyna and Elisabeth Schlegl., The (Not So) Short Introduction to LATEX2e, Samurai Media Limited (or available online at http://mirrors.ctan.org/info/lshort/english/lshort.pdf)
3. LATEX Tutorials - A Primer, Indian TeX Users Group, available online at https://www.tug.org/twg/mactex/tutorials/ltxprimer-1.0.pdf
4. H. J. Greenberg. A Simplified introduction to LATEX, available online at https://www.ctan.org/tex-archive/info/simplified-latex/
5. Using Kile - KDE Documentation, https://docs.kde.org/trunk4/en/extragear_office/kile/quick-using.html
6. Amsmath and geometry package available in Ctan.org.


| Semester:II | Value Added Course : I | Introduction to LATEX | Credit : 2 | Allotted hours per week: 3 |
|---|---|---|---|---|

**CO01:** Type their own mathematical article/notes/book/journal paper/project work. Meticulously prepare their own mathematical notes.

**CO02:** Understand basic structure of Latex 2e and conversions of them to various formats. Typeset and compile documents with titles, sectioning and enumeration etc.

**CO03:** Use various style files and in particular amsmath, amsfonts, amsthm. Understand how to align math equations, matrices etc.

**CO04:** Include the figures in various formats into their latex document and compile it successfully.

**CO05:** Utilize bibtex feature of including bibliographies and indexes.

| PSO-PO-CO MAPPING MATRIX | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| PO & PSO / CO | PO01 | PO02 | PO03 | PO04 | PO05 | PSO01 | PSO02 | PSO03 | PSO04 | PSO05 |
| CO01 | 3 | 1 | 2 | 1 | 1 | 3 | 2 | 3 | 2 | 2 |
| CO02 | 1 | 3 | 1 | 2 | 1 | 2 | 2 | 1 | 3 | 2 |
| CO03 | 2 | 1 | 3 | 2 | 1 | 3 | 1 | 3 | 2 | 1 |
| CO04 | 1 | 2 | 1 | 3 | 1 | 1 | 3 | 3 | 1 | 2 |
| CO05 | 1 | 2 | 1 | 1 | 3 | 2 | 1 | 2 | 3 | 2 |

**Second Year** **CORE COURSE VI TOPOLOGY** **Semester: III**

**Code:** **(Theory)** **Credit: 5**

**COURSE OBJECTIVES:**

- To stimulate the analytical mind of the students
- Enable them to acquire sufficient knowledge and skill in the subject that will make them competent in various areas of Mathematics.

**UNIT – I:**

**Metric Spaces:** The Definition and some Examples – Open sets – Closed sets – Convergence, Completeness and Baire's theorem, Continuous mappings – Spaces of continuous functions – Euclidean and Unitary Spaces.

**UNIT – II:**

**Topological Spaces:** The Definition and some Examples – elementary concepts – open bases and open sub bases – weak topologies – The function algebra $C\ (X, R)$ and $C\ (X, C)$.

**UNIT – III:**

**Compactness:** Compact spaces – Product of spaces – Tychnoff's theorem and locally compact spaces – Compactness for Metric spaces – Ascoli's theorem.

**UNIT – IV:**

**Separation:** $_1$-spaces and Hausdorff spaces – Completely regular spaces and normal spaces - The Urysohn lemma and Tietze Extension Theorem - The Urysohn imbedding theorem – The Stone-Cechcompactification.

**UNIT – V:**

**Connectedness and Approximation:** Connected spaces – The components of a space – Totally disconnected spaces - Local connected spaces – The Weierstrass approximation theorem – The Stone-Weierstrass theorem.

**UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):**

Elementary concepts from Algebraic topology.

**REFERENCES:**

1. George F. Simmons, "Introduction to Topology and Modern Analysis", McGraw Hill Book Company 1963.

   UNIT I Chapter 2: Page: 9-15
   UNIT II Chapter 3: Page: 16-20
   UNIT III Chapter 4: Page: 21-25

UNIT IV Chapter 5: Page: 26-30
UNIT V Chapter 6,7: Page: 31-36
2. James. R. Munkres, "Topology", second Edition, Prentice Hall of India Pvt.,Ltd., New Delhi 2005
3. J. Dugundji, "Topology" Prentice hall of India, New Delhi 1975.
4. J. L. Kelly, "General topology", Van Nostrand Reinhold Co., New York.
5. M. G. Murdeswar "General Topology", Academic press, 1964
6. K. D. Joshi "Introduction to General Topology", Addison-Wesley, 1994.
7. S. Kumaresan, "Topology of Metric Spaces" Alpha Science International Ltd.Harrow, U.K.
8. https://ocw.mit.edu/courses/18-901-introduction-to-topology-fall- 2004/pages/lecture-notes/
9. https://www.topologywithouttears.net/topbook.pdf

| Semester:III | Core Course : VI | Topology | Credit : 5 | Allotted hours per week: 6 |
|---|---|---|---|---|

**CO01:** Study and Understand the concepts of metric spaces, topological spaces

**CO02:** Understand the concepts of open bases and open sub bases

**CO03:** Understand the concepts of Compactness

**CO04:** Understand the concepts of connectedness and separation axioms

**CO05:** Provide patience to grapple with life outside the campus.

| PSO-PO-CO MAPPING MATRIX | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **PO & PSO / CO** | **PO01** | **PO02** | **PO03** | **PO04** | **PO05** | **PSO01** | **PSO02** | **PSO03** | **PSO04** | **PSO05** |
| **CO01** | **3** | **1** | **2** | **1** | **1** | **1** | **2** | **3** | **3** | **3** |
| **CO02** | **1** | **2** | **1** | **3** | **1** | **2** | **2** | **1** | **3** | **2** |
| **CO03** | **1** | **3** | **3** | **1** | **1** | **3** | **2** | **3** | **3** | **1** |
| **CO04** | **1** | **1** | **3** | **2** | **1** | **3** | **2** | **3** | **1** | **2** |
| **CO05** | **1** | **2** | **3** | **3** | **1** | **2** | **1** | **2** | **2** | **3** |

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**Second Year** **CORE COURSE VII** **Semester: III**

**MEASURE THEORY AND INTEGRATION**

**Code:** **(Theory)** **Credit: 5**

**COURSE OBJECTIVES:**

- This course will enable the students to Study financial mathematics through various models and various aspects of financial mathematics

**UNIT – I:**

**Measure on Real line:** Lebesgue outer measure - Measurable sets - Regularity - Measurable function - Borel and Lebesgue measurability.

**UNIT – II:**

**Integration of non-negative functions:** The General integral - Integration of series - Riemann and Lebesgue integrals.

**UNIT – III:**

**Abstract Measure spaces:** Measures and outer measures - Completion of measures - Measure spaces - Integration with respect to a measure.

**UNIT – IV:**

**Convergence in Measure:** Almost uniform convergence- Signed Measures and Halin Decomposition –The Jordan Decomposition – Measurability in a Product space – The product Measure and Fubini's Theorem.

**UNIT – V:**

**The Classical Banach spaces:** LP spaces – Minkowski and Holder's inequality – Completeness – Approximation in LP spaces.

**UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):**

Riesz- Markov Kakutani Theorem.

**REFERENCES:**


1. G.De Barra, Measure Theory and Integration, New age international (p) Limited.
2. H. L. Royden, Real Analysis, 3rd Edition, PHI Ltd.
   UNIT – I Chapter II: Sec 2.1 to 2.5 of (1)
   UNIT – II Chapter III: Sec 3.1 to 3.4 of (1)
   UNIT – III Chapter V: Sec 5.1 to 5.6 of (1)
   UNIT – IV Chapter VII: Sec 7.1, 7.2 Chapter VIII: Sec 8.1, 8.2 Chapter X: Sec 10.1,10.2 of (1)
   UNIT – V Chapter VI: Sec 6.1 to 6.4 of (2)


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3. M.E. Munroe, Measure and Integration, by Addison - Wesley PublishingCompany, Second Edition, 1971.
4. P.K. Jain, V.P. Gupta, Lebesgue Measure and Integration, New AgeInternational Pvt Limited Publishers, New Delhi, 1986, Reprint 2000.
5. Richard L. Wheeden and AntoniZygmund, Measure and Integral: AnIntroduction to Real Analysis, Marcel Dekker Inc. 1977.
6. Inder, K. Rana, An Introduction to Measure and Integration, NarosaPublishing House, New Delhi, 1997.
7. https://www.pdfdrive.com/download.pdf?id=161198423&h=e1440b6a78771 4e507bfa8eeedb5b4d4&u=cache&ext=pdf
8. https://www.pdfdrive.com/download.pdf?id=183696899&h=fcc838426bc7fc4 9a384dd10730fe715&u=cache&ext=pdf

| Semester:III | Core Course : VII | Measure Theory and Integration | Credit : 5 | Allotted hours per week: 6 |
|---|---|---|---|---|

**CO01:** Learn the basic concepts of measure and integration.

**CO02:** Comprehend the differences between different types of convergences.

**CO03:** Understand the concepts of Classical Banach Spaces

**CO04:** Learn completeness and approximation in *L*p-spaces.

**CO05:** An overview of the central results of the theory of Lebesgue integration.

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| PSO-PO-CO MAPPING MATRIX | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| PO & PSO / CO | PO01 | PO02 | PO03 | PO04 | PO05 | PSO01 | PSO02 | PSO03 | PSO04 | PSO05 |
| CO01 | 1 | 3 | 2 | 1 | 1 | 3 | 3 | 1 | 2 | 3 |
| CO02 | 1 | 1 | 3 | 2 | 1 | 1 | 2 | 2 | 3 | 2 |
| CO03 | 1 | 3 | 2 | 1 | 1 | 2 | 2 | 3 | 1 | 2 |
| CO04 | 1 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 |
| CO05 | 1 | 3 | 2 | 1 | 1 | 2 | 3 | 2 | 2 | 1 |

**Second Year** **CORE CHOICE COURSE III** **Semester: III**

**2) ALGEBRAIC NUMBER THEORY**

**Code:** **(Theory)** **Credit: 5**

**COURSE OBJECTIVES:**

- To expose the students to the charm, niceties and nuances in the world of numbers.
- To highlight some of the Applications of the Theory of Numbers.

**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.

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**UNIT – V:**

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

**UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):**

Prime Number Theorem and its applications.

**REFERENCES:**


1. Ivan Niven, Herbert S, Zuckerman and Hugh L, Montgomery, An Introduction to the Theory of Numbers, Fifth edn., John Wiley & Sons Inc, 2004.
   UNIT I Chapter 1 and Chapter 2: Sec 2.1 to 2.3
   UNIT II Chapter 2: Sec 2.4 to 2.9
   UNIT III Chapter 2: Sec 2.10, 2.11 Chapter 3: Sec 3.1 to 3.3


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UNIT IV Chapter 3: Sec 3.4 to 3.7 and Chapter 4
UNIT V Chapter 5: Sec 5.1 to 5.4.

2. Elementary Number Theory, David M. Burton W.M.C. Brown Publishers,Dubuque, Lawa, 1989.
3. Number Theory, George Andrews, Courier Dover Publications,1994.
4. Fundamentals of Number Theory, William J. Leveque Addison-WesleyPublishing Company, Phillipines, 1977.
5. http://www.math.toronto.edu/~ila/Neukirch_Algebraic_number_theory.pdf
6. https://www.pdfdrive.com/download.pdf?id=188938191&h=4d0f9c871d3eb0 49e961899e1123111b&u=cache&ext=pdf

| Semester:III | Core Choice Course : III | Algebraic Number Theory | Credit : 5 | Allotted hours per week: 6 |
|---|---|---|---|---|

**CO01:** Understand and work numerous problems on concepts of divisibility and primes.Gain expertise in Euler's totient, Fermat's, Euler's and Wilson's Theorems and work on applications illustrating them.

**CO02:** Solve congruences as application of Chinese remainder Theorem. Understand number theory from algebraic point of view there by improving their sense of abstraction.

**CO03:** Discuss Quadratic residue and Jacobi symbol and work on sum of two squares problems.

**CO04:** Attained mastery in the fundamentals of greatest integer function and recurrence functions and attacking combinatorial problems using them.

**CO05:**Solve simple simultaneous linear Diophantine equations.

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| PSO-PO-CO MAPPING MATRIX | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| PO & PSO / CO | PO01 | PO02 | PO03 | PO04 | PO05 | PSO01 | PSO02 | PSO03 | PSO04 | PSO05 |
| CO01 | 1 | 3 | 2 | 1 | 1 | 3 | 2 | 2 | 2 | 1 |
| CO02 | 1 | 2 | 3 | 1 | 1 | 3 | 1 | 2 | 3 | 2 |
| CO03 | 1 | 1 | 3 | 2 | 1 | 1 | 3 | 3 | 2 | 2 |
| CO04 | 3 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 3 | 2 |
| CO05 | 2 | 1 | 3 | 1 | 1 | 3 | 2 | 2 | 1 | 3 |

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**Second Year** **ELECTIVE COURSE III** **Semester: III**

**1)INTEGRAL EQUATIONS AND CALCULUS OF VARIATIONS**

**Code:** **(Theory)** **Credit: 4**

**COURSE OBJECTIVES:**

- To obtain thorough analysis of various aspects of calculus of variations.
- To acquire the knowledge of solving problems in the fields of mechanics and mathematical physics.

## CALCULUS OF VARIATIONS

**UNIT – I:**

Problems with fixed boundaries.

**UNIT – II:**

Problems with moving boundaries - Externals with corners - One sided variations.

**UNIT – III:**

Sufficient conditions for Extremum - Conditional Extremum Problems.

## 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.

**UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):**

Variational problems in fluid flow and Heat transfer.

**REFERENCES:** *****


- Ram. P. Kanwal - Linear Integral Equations Theory and Practice, Birkhauser Boston, 2012.

- L. Elsgolts, Differential equations and the calculus of variations, UniversityPress of the Pacific, 2003.
  UNIT – I Chapter 6 of (2)
  UNIT – II Chapter 7,8 of
  (2)UNIT – III Chapter 9,10 of
  (2)UNIT – IV Chapter 1,2 of
  (1)UNIT – V Chapter 3,4 of
  (1)
- S.J. Mikhlin, Linear Integral Equations (translated from Russian), HindustanBook Agency, 1960.
- I.N. Snedden, Mixed Boundary Value Problems in Potential Theory, North Holland, 1966.
- https://www.researchgate.net/file.PostFileLoader.html?id=56c4564d5cd9e3c 21f8b457e&assetKey=AS:330076274085892@1455707725045
- https://www.researchgate.net/profile/Andrei-Polyanin/publication/275518932_Handbook_of_Integral_Equations_Second_ Edition/links/5657321b08aeafc2aac0c490/Handbook-of-Integral-Equations-Second-Edition.pdf


| Semester:III | Elective Course : III | Integral Equations and Calculus of Variations | Credit : 4 | Allotted hours per week: 6 |
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**CO01:** Understand the concepts of variation and its properties.Use Euler's equation to solve various types of variational problems with fixed boundaries.

**CO02:** Modify the Euler's formula for a class of curves with moving boundary points.Solve problems related with reflection and refraction, diffraction of light rays.

**CO03:** Derive sufficient conditions based on second variation. Classify Fredholm, Volterra and singular type integral equations.

**CO04:** Solve integral equations using Fredholm theorem, Fredholm Alternative theorem and method of successive approximations.

**CO05:** Understand the classical Fredholm theory.

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| PSO-PO-CO MAPPING MATRIX | | | | | | | | | | |
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| PO & PSO / CO | PO01 | PO02 | PO03 | PO04 | PO05 | PSO01 | PSO02 | PSO03 | PSO04 | PSO05 |
| CO01 | 1 | 3 | 1 | 2 | 1 | 3 | 3 | 2 | 1 | 1 |
| CO02 | 1 | 2 | 1 | 3 | 1 | 2 | 1 | 1 | 2 | 3 |
| CO03 | 1 | 3 | 2 | 1 | 2 | 2 | 3 | 1 | 2 | 2 |
| CO04 | 1 | 2 | 3 | 1 | 2 | 2 | 1 | 3 | 2 | 2 |
| CO05 | 2 | 1 | 1 | 2 | 3 | 1 | 1 | 3 | 3 | 3 |

**Second Year** **VALUE ADDED COURSE II** **Semester: III**

1) **MATHEMATICS FOR COMPETITIVE EXAMINATIONS**

**Code:** **(Theory)**

**Credit: 2COURSE OBJECTIVES:**

- To gain quantitative aptitude required in the present scenario.
- To emphasize the right perceptive needed to crack such problems and understandthe recurring pattern in those problems.

**UNIT – I:**

Problems on Numbers- Average-Problems on Ages.

**UNIT – II:**

Percentage-Profit & Loss-Simple Interest-Compound Interest.

**UNIT – III:**

Ratio & Proportion-Partnership-Calender-Clocks.

**UNIT – IV:**

Time and work-Pipes & Cistern.

**UNIT – V:**

Time & Distance-Problems on Trains-Boats and Streams.

**UNIT – VI: CURRENT CONTOURS (For Continuous Internal Assessment Only):**

Simple problems using sets, functions, group theory etc.

**REFERENCES:** *****

1. Dinesh Khattar, The Pearson Guide to Quantitative Aptitude for Competitive Examinations, Pearson Education, 3 edition, 2015.

| Semester:III | Value Added Course : II | Mathematics for Competitive Examinations | Credit : 2 | Allotted hours per week: 3 |
|---|---|---|---|---|

**CO01:** Face competitive examinations with confidence.Solve a lot of problems on numbers and averages and problems on ages.

**CO02:** Get a lot of training on percentage, profit and loss.Crack problems on calculating simple interest and compound Interest.

**CO03:** Work on a plenty of problems on time and work. Get working knowledge on ratios and proportions.

**CO04:** Calculate time, distance, speed given the other two and solve lot of problems.

**CO05:** Acquire problem solving ideas on trains, boats and streams.

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| PSO-PO-CO MAPPING MATRIX | | | | | | | | | | |
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| CO01 | 1 | 3 | 2 | 1 | 2 | 3 | 2 | 3 | 2 | 1 |
| CO02 | 1 | 2 | 3 | 1 | 1 | 2 | 3 | 2 | 1 | 2 |
| CO03 | 1 | 1 | 2 | 3 | 2 | 2 | 1 | 2 | 3 | 2 |
| CO04 | 2 | 1 | 2 | 3 | 1 | 1 | 2 | 3 | 2 | 2 |
| CO05 | 1 | 2 | 1 | 3 | 1 | 2 | 2 | 1 | 2 | 3 |

**Second Year** **CORE COURSE VIII** **Semester: IV**

**FUNCTIONAL ANALYSIS**

**Code:** **(Theory)** **Credit: 5**

**COURSE OBJECTIVES:**

- To introduce Banach spaces and Hilbert spaces.
- To study fundamental theorems of functional analysis that includes Hahn Banach theorem, Open mapping theorem and Uniform boundedness principle and introduce operator theory and Banach algebras leading to the spectral theory of operators.

**UNIT – I:**

**Banach Spaces:** The definition and some examples – Continuous linear transformations – The Hahn-Banach theorem.

**UNIT – II:**

**Banach Spaces:** The natural embedding of N in N** – The open mapping theorem – The conjugate of an operator.

**UNIT – III:**

**Hilbert Spaces:** The definition and some simple properties – Orthogonal complements – Orthonormal sets – The conjugate space H*.

**UNIT – IV:**

**Hilbert Spaces:** The adjoint of an operator – Self-adjoint operators – Normal and unitary operators – Projections.

**UNIT – V:**

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

**UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):**

Generating topologies -Weak and Weak Topologies - Banach-Alaoglu Theorem.

**REFERENCES:**


1. G. F. Simmons, Introduction to Topology and Modern Analysis, Tata McGraw -Hill, 2004.
   UNIT – I Chapter 9 Sec 46 to 48
   UNIT – II Chapter 9 Sec 49 to 51
   UNIT – III Chapter 10 Sec 52 to 55
   UNIT – IV Chapter 10 Sec 56 to 59
   UNIT – V Chapter 12 Sec 302 to 317.


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2. E. Kreyszig, Introductory Functional Analysis with Applications, John Wiley &sons, 1978.
3. G. Bachman and Lawrence Narici, Functional Analysis, Dover Publications, 2000.
4. H. C. Goffman and G. Fedrick, First course in Functional Analysis, PrenticeHall of India, New Delhi, 1987.
5. E. Taylor and D. C. Lay, Introduction to Functional Analysis, second edition,John Wiley & Sons, 1980.
6. Bollabas, Linear Analysis - An introductory course, Cambridge University Press (Indian edition), 1999.
7. V. Limaye, Functional Analysis, Revised Third Edition, New Age International,2017.
8. M. Thamban Nair, Functional Analysis - A First Course, Prentice Hall of India,2010.
9. S. Ponnusamy, Foundations of Functional Analysis, Narosa Publishing House,2002.
10. https://59clc.files.wordpress.com/2012/08/functional-analysis- -rudin-2th.pdf
11. https://people.math.ethz.ch/~salamon/PREPRINTS/funcana.pdf

| Semester:IV | Core Course : VIII | Functional Analysis | Credit : 5 | Allotted hours per week: 6 |
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**CO01:** Identify Banach spaces and analyse their properties with other types of spaces.

**CO02:** Examine and identify properties of complex Banach spaces- Hilbert spaces.

**CO03:** Apply the analytical techniques and theoretical knowledge in Hilbert Spaces. Findout and determine orthonormal sets.

**CO04:** Explain various properties of Hilbert spaces.

**CO05:** Attain knowledge and experience of working with many pure mathematical problems.

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| PSO-PO-CO MAPPING MATRIX | | | | | | | | | | |
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**Second Year** **CORE COURSE IX** **Semester: IV**

**DIFFERENTIAL GEOMETRY**

**Code:** **(Theory)** **Credit: 5**

**COURSE OBJECTIVES:**

- To introduce the notion of surfaces and their properties.
- To study geodesics and differential geometry of surfaces.

**UNIT – I:**

**Space Curves:** Definition of a space curve - Arc length - tangent - normal and binormal - curvature and torsion - contact between curves and surfaces- tangent surface- involutes and evolutes- Intrinsic equations - Fundamental Existence Theorem for space curves- Helics.

**UNIT – II:**

**Intrinsic Properties of a Surface:** Definition of a surface - curves on a surface - Surface of revolution - Helicoids - Metric- Direction coefficients - families of curves- Isometric correspondence- Intrinsic properties.

**UNIT – III:**

**Geodesics:** Geodesics - Canonical geodesic equations - Normal property of geodesics- Existence Theorems - Geodesic parallels - Geodesics curvature- Gauss- Bonnet Theorem - Gaussian curvature- surface of constant curvature.

**UNIT – IV:**

**Non Intrinsic Properties of a Surface:** The second fundamental form- Principal curvature - Lines of curvature - Developable – Developable associated with space curves and with curves on surface - Minimal surfaces - Ruled surfaces.

**UNIT – V:**

**Differential Geometry of Surfaces:** Compact surfaces whose points are umblics- Hilbert's lemma - Compact surface of constant curvature - Complete surface and their characterization - Hilbert's Theorem - Conjugate points on geodesics.

**UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):**

Elementary concepts from commutative algebra. The Gauss Bonet theorems.

**REFERENCES:**


1. T.J. Willmore, An Introduction to Differential Geometry, Oxford University Press,(17th Impression) New Delhi 2002. (Indian Print).
   UNIT – I Chapter I: Sections 1 to 9.
   UNIT – II Chapter II: Sections 1 to 9.
   UNIT – III Chapter II: Sections 10 to 18.

UNIT – IV Chapter III: Sections 1 to 8.UNIT – V Chapter IV: Sections 1 to 8.

2. Struik, D.T. Lectures on Classical Differential Geometry, Addison - Wesley, Mass. 1950.
3. Kobayashi S. and Nomizu. K. Foundations of Differential Geometry,Interscience Publishers, 1963.
4. Wihelm Klingenberg: A course in Differential Geometry, Graduate Texts inMathematics, Springer Verlag, 1978.
5. J.A. Thorpe Elementary topics in Differential Geometry, Under - graduate Texts in Mathematics, Springer - Verlag 1979.
6. https://www.pdfdrive.com/download.pdf?id=5949406&h=ec626392725b62c6 8c495d75f553f7fa&u=cache&ext=pdf
7. https://archive.org/details/differentialgeom003681mbp

| Semester:IV | Core Course : IX | Differential Geometry | Credit : 5 | Allotted hours per week: 6 |
|---|---|---|---|---|

**CO01:** Have a solid understanding of the subjects, linear algebra, multivariable calculus and differential equations and a basic knowledge of theoretical physics. Sketch and workout graphs, level sets, tangent space and surfaces of given smooth

**CO02:** Good knowledge on calculus of vector fields.Understand how Gauss map helps to identify the surfaces that are mapped onto the unit n-sphere.

**CO03:** Describe surfaces as a solution sets of differential equations.Exhibit geodesics on surfaces.

**CO04:** Learn how parametrizations of plane curves can be used to evaluate integrals over the curve.

**CO05:** Compute the Gaussian curvature of various surfaces.

| PSO-PO-CO MAPPING MATRIX | | | | | | | | | | |
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**CORE COURSE X** **Semester: IV**

**FLUID DYNAMICS**

**Second Year**

**Code:** **(Theory)** **Credit: 5**

**COURSE OBJECTIVES:**

- To give the students an introduction to the behaviour of fluids in motion.
- To give the students a feel of the applications of Complex Analysis in the analysis of the flow of liquids.

**UNIT – I:**

Real Fluids and Ideal Fluids - Velocity of a Fluid at a point – Streamlines and Path lines: Steady and Unsteady Flows – The Velocity potential – The Vorticity vector – Local and Particle Rates of Change – The Equation of continuity – Worked examples – Acceleration of a Fluid – Conditions at a rigid boundary – General analysis of fluid motion – Pressure at a point in a Fluid at Rest – Pressure at a point in Moving Fluid – Conditions at a Boundary of Two Inviscid Immiscible Fluids – Euler's equation of motion – Bernoulli's equation – Worked examples.

**UNIT – II:**

Discussions of a case of steady motion under conservative body forces – Some potential theorems – Some Flows Involving Axial Symmetry – Some special two-Dimensional Flows-Impulsive Motion. Some three- dimensional Flows: Introduction – Sources, Sinks and Doublets – Images in a Rigid infinite Plane – Axi-Symmetric Flows; Stokes stream function.

**UNIT – III:**

Some Two- Dimensional Flows: Meaning of a Two- Dimensional Flow – Use of cylindrical polar co-ordinates – The stream function – The Complex Potential for Two- Dimensional, Irrotational , Incompressible Flow – complex velocity potentials for Standard Two Dimensional Flows – Some worked examples – The Milne- Thomson circle theorem and applications – The theorem of Blasius.

**UNIT – IV:**

The use of conformal Transformation and Hydro dynamical Aspects – Vortex rows. Viscous flow Stress components in a real fluid - relations between Cartesian components of stress - Translational Motion of Fluid element – The Rate of Strain

Quadraic and Principle Stresses – Some further properties of the rate of strain quardric - Stress analysis in fluid motion – Relations between stress and rate of strain - The coefficient of viscosity and laminar flow – The Navier- Stokes equations of motion of a viscous fluid.

**UNIT – V:**

Some solvable problems in viscous flow – Steady viscous flow in tubes of uniform cross section – Diffusion of vorticity – Energy Dissipation due to viscosity – Steady Flow past a Fixed Sphere – Dimensional Analysis; Reynolds Number – Prandtl's Boundary Layer.

**UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):**

Gas Dynamics and Magneto hydrodynamics.

**REFERENCES:**


1. Text Book of Fluid Dynamics by F.Chorlton ,CBS Publishers & Distributors, New Delhi ,1985.
   UNIT – I Chapter 2 and Chapter 3: Sections 3.1 to 3.6UNIT – II Chapter 3: Sections 3.7 to 3.11 and Chapter 4: Sections 4.1,4.2,4.3,4.5
   UNIT – III Chapter 5: Sections : 5.1 to 5.9 except 5.7
   UNIT – IV Chapter 5: Section 5.10, 5.12 and Chapter 8: Sections 8.1 to 8.9
   UNIT – V Chapter 8: Sections 8.10 to 8.16.
2. Computational Fluid Dynamics: An Introduction, J.F. Wendt J.D. Anderson, G. Degrez and E. Dick, Springer – Verlag, 1996.
3. Computational Fluid Dynamics,The Basics with Applicatios, J. D. Anderson, McGrawHill, 1995.
4. An Introduction to Fluid Mechanics, Foundation Books, G. K. Batchelor, New Delhi,1984.
5. A Mathematical Introduction to Fluid Dynamics, A. J. Chorin and A. Marsden,Springer- Verlag, New York, 1993.
6. Foundations of Fluid Mechanics, S. W. Yuan, Prentice Hall of India Pvt Limited, NewDelhi, 1976.
7. An Introduction to Fluid Dynamics, R. K. Rathy Oxford and IBH Publishing Company, New Delhi, 1976.
8. http://home.iitk.ac.in/~nikhilk/Book.pdf
9. http://www.issp.ac.ru/ebooks/books/open/Advanced_Fluid_Dynamics.pdf


| Semester:IV | Core Course : X | Fluid Dynamics | Credit : 5 | Allotted hours per week: 6 |
|---|---|---|---|---|

**CO01:** Understand the basic ideas of fluid velocity, streamlines and rotational and irrotational flows. Understand the meanings of fundamental terms like pressure and body force.

**CO02:** Develop special mathematical methods involving images and complex variables for incompressible fluids. Derive images in three dimension.

**CO03:** Solve problems using Milne-Thomson circle theorem. Understand Navier's stokes of motion

**CO04:** Unify many developed principles.

**CO05:** Solve problems related with cosmic electrodynamics and nuclear engineering.

| PSO-PO-CO MAPPING MATRIX | | | | | | | | | | |
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**Second Year** **ELECTIVE COURSE IV** **Semester: IV**

**3) ALGEBRAIC TOPOLOGY**

**Code:** **(Theory)** **Credit: 4**

**COURSE OBJECTIVES:**

- To introduce the notion of homotopy and covering spaces.
- To study the Jordan Curve Theorem.

**UNIT – I:**

Homotopy of Paths-The Fundamental Group-Covering spaces.

**UNIT – II:**

The Fundamental group of the circle – The Fundamental group of the punctured plane- The Fundamental group of $S^n$.

**UNIT – III:**

Fundamental groups of surfaces- Essential and Inessential maps-The Fundamental theorem of algebra.

**UNIT – IV:**

Homotopy type – The Jordan separation theorem.

**UNIT – V:**

The Jordan Curve Theorem.

**UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):**

Homology theory

**REFERENCES:**

1. Topology – A first course by James R.Munkres, Prentice-Hall of India Pvt Ltd, Third print.
   UNIT – I Chapter 9: Sections 51-53
   UNIT – II Chapter 9: Sections 54,55
   UNIT – III Chapter 9: Sections 56,59,60
   UNIT – IV Chapter 10: Sections 58,61
   UNIT – V Chapter 7: Sections 63
2. A basic course in Algebraic Topology by William S Massey, Springer, First Edition.
3. Lecture notes on Elementary Topology and Geometry (Under graduate Texts in Mathematics) by I.M. Singer and John A Thorpe, Springer-Verlag, New York.
4. Elements of Algebraic Topology by James R. Munkres ,Addition-Wesley Publishing Company-1984

5. Allen Hatcher, Algebraic Topology, Cambridge University Press, 2002.
6. https://pi.math.cornell.edu/~hatcher/AT/AT.pdf
7. https://www.maths.ed.ac.uk/~v1ranick/papers/diecktop.pdf

| Semester:IV | Core Course : X | Fluid Dynamics | Credit : 5 | Allotted hours per week: 6 |
|---|---|---|---|---|

**CO01:** Understand the basic ideas of fluid velocity, streamlines and rotational and irrotational flows. Understand the meanings of fundamental terms like pressure and body force.

**CO02:** Develop special mathematical methods involving images and complex variables for incompressible fluids. Derive images in three dimension.

**CO03:** Solve problems using Milne-Thomson circle theorem. Understand Navier's stokes of motion

**CO04:** Unify many developed principles.

**CO05:** Solve problems related with cosmic electrodynamics and nuclear engineering.

| PSO-PO-CO MAPPING MATRIX | | | | | | | | | | |
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| **PO & PSO / CO** | **PO01** | **PO02** | **PO03** | **PO04** | **PO05** | **PSO01** | **PSO02** | **PSO03** | **PSO04** | **PSO05** |
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| **Semester:IV** | **Core Course : X** | **Fluid Dynamics** | **Credit : 5** | **Allotted hours per week: 6** |
|---|---|---|---|---|

**CO01:** Understand the basic ideas of fluid velocity, streamlines and rotational and irrotational flows. Understand the meanings of fundamental terms like pressure and body force.

**CO02:** Develop special mathematical methods involving images and complex variables for incompressible fluids. Derive images in three dimension.

**CO03:** Solve problems using Milne-Thomson circle theorem. Understand Navier's stokes of motion

**CO04:** Unify many developed principles.

**CO05:** Solve problems related with cosmic electrodynamics and nuclear engineering.

| PSO-PO-CO MAPPING MATRIX | | | | | | | | | | |
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**Second Year** **ELECTIVE COURSE IV** **Semester: IV**

**3) ALGEBRAIC TOPOLOGY**

**Code:** **(Theory)** **Credit: 4**

**COURSE OBJECTIVES:**

- To introduce the notion of homotopy and covering spaces.
- To study the Jordan Curve Theorem.

**UNIT – I:**

Homotopy of Paths-The Fundamental Group-Covering spaces.

**UNIT – II:**

The Fundamental group of the circle – The Fundamental group of the punctured plane- The Fundamental group of $S^n$.

**UNIT – III:**

Fundamental groups of surfaces- Essential and Inessential maps-The Fundamental theorem of algebra.

**UNIT – IV:**

Homotopy type – The Jordan separation theorem.

**UNIT – V:**

The Jordan Curve Theorem.

**UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):**

Homology theory

**REFERENCES:**

1. Topology – A first course by James R.Munkres, Prentice-Hall of India Pvt Ltd,

Third print.

UNIT – I Chapter 9: Sections 51-53
UNIT – II Chapter 9: Sections 54,55
UNIT – III Chapter 9: Sections 56,59,60
UNIT – IV Chapter 10: Sections 58,61
UNIT – V Chapter 7: Sections 63

2. A basic course in Algebraic Topology by William S Massey, Springer, First Edition.
3. Lecture notes on Elementary Topology and Geometry (Under graduate Texts in Mathematics) by I.M. Singer and John A Thorpe, Springer-Verlag, New York.
4. Elements of Algebraic Topology by James R. Munkres ,Addition-Wesley Publishing Company-1984

5. Allen Hatcher, Algebraic Topology, Cambridge University Press, 2002.
6. https://pi.math.cornell.edu/~hatcher/AT/AT.pdf
7. https://www.maths.ed.ac.uk/~v1ranick/papers/diecktop.pdf

| Semester:IV | Elective Course : IV | Algebraic Topology | Credit : 4 | Allotted hours per week: 6 |
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**CO01:** Review the basic topological concepts connecting geometry.Understand quotient topology and how the identification works.

**CO02:** Discuss on the concept of homotopy and homotopy equivalence of topological spaces.

**CO03:** Compute the fundamental groups of standard topological spaces.

**CO04:** Learn thoroughly covering homotopy theorem.

**CO05:** Solve problems related with cosmic electrodynamics and nuclear engineering.

| PSO-PO-CO MAPPING MATRIX | | | | | | | | | | |
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