# GURU NANAK COLLEGE (AUTONOMOUS)

**VELACHERY ROAD, CHENNAI – 600042**

**(Re-accredited at 'A-Grade' by NAAC)**

**Affiliated to University of Madras**

## MASTER OF SCIENCE (MATHEMATICS)

(SEMESTER PATTERN WITH CHOICE BASED CREDIT SYSTEM)

# SYLLABUS

(For the candidates admitted for the Academic year 2021 - 22 and thereafter)

# PREAMBLE

M.Sc. Mathematics programme is of minimum 91 credits spread over four semesters and a skill development course in each semester for additional credits. The programme establishes knowledge in main sub fields of pure and applied mathematics. In the first semester, for the total of 21 credits, the programme has four core courses, one elective course and one soft skill course. In the second semester, for the total of 24 credits, the programme has four core courses, one elective course, one extra disciplinary elective course and one soft skill course. In the third semester, for the total of 24 credits, the programme has three core courses, one elective, one extra disciplinary elective course, one soft skill course and summer internship. In the fourth semester, for the total of 24 credits, the programme has four core courses, two elective courses, one soft skill course. As unique features, the programme has Practical for Programming with C++ as elective course-2 and a project work as core course-15. The M.Sc. Mathematics programme has autonomy and it has been bestowed to modify the existing courses and add the need based new courses. The programme is providing opportunity to study extra disciplinary elective courses related to three other programmes M.S.W, M.Sc. Zoology and M.A. Defence Management & Strategic Studies. Overall the programme is catering the need of students pursuing it by developing knowledge and skills in many aspects.

# LEARNING OUTCOME BASED CURRICULUM FRAMEWORK

From the Academic Year (2021- 22) and thereafter

## VISION

To instill the scientific dogmas of nature; to provoke the interest towards learning science and allied subjects; to equip the students with scientific skills to acquire competency needed for employment; to inculcate professional ethics and value-based education to improve socio-economic status; to impart interdisciplinary approach for identifying and solving real world scientific problems through research.

## MISSION

1. To facilitate an encouraging and exciting environment to develop the scientific temper in students through a curriculum based on fundamental as well as advanced scientific knowledge.
2. To provide technical skills in the respective disciplines through conducting practical training including internship as well as project, this will hone the skills necessary to become a successful mathematician, physicist, chemist, biotechnologist and visual communication professional.
3. To inculcate interdisciplinary knowledge, elective subjects in various fields are offered, thereby providing an opportunity to the students to identify their interest towards a particular field and pursue the passion.

## PROGRAMME OUTCOMES
## MASTER OF SCIENCE (MATHEMATICS)

The following points are the expected outcomes of the two-year M.Sc. Mathematics programme of Guru Nanak College:

1. Develop specific knowledge in main subfields of pure and applied mathematics to apply them independently to solve problems of real-life situations.
2. Demonstrate an understanding of Abstract Algebra, Analysis, Differential, Difference Equations, Topology, Geometry, Graphs, Fuzzy Sets, Statistics, Stochastic Processes, Mechanics, Number Theory, Calculus of Variations & Integral Equations, Programming in C++ and Operations Research.
3. Demonstrate skills in analyzing concepts and solving given problems at a high level of abstraction.
4. Inculcate scientific knowledge in varying research areas of core and elective subjects through the curriculum where the summer internship is being a part.
5. Create ability to apply mathematical methodologies in various sectors like banking, IT, TNPSC, UPSC, etc.

## PROGRAMME SPECIFIC OUTCOMES
## MASTER OF SCIENCE (MATHEMATICS)

1. Establish knowledge of the basics as well as advanced level in each core subject through extra classes too, whenever needed, which make students of different performing levels, age categories learn with ease and compete with each other.
2. Generate students as motivated Teachers in Schools & Colleges as Researchers and as successful professionals in the various other fields by providing one to one interactions with the students to develop their skills in curricular & co-curricular activities.

**M.Sc. MATHEMATICS**
**COURSE STRUCTURE OF 2022-2024 BATCH**

| Semester | Part | Course Component | Subject Code | Subject Name | Credits | Hours | Internal | External | Total |
|---|---|---|---|---|---|---|---|---|---|
| Semester – I | III | Core-1 | 21PMAT301 | Algebra-I | 4 | 6 | 50 | 50 | 100 |
| | III | Core-2 | 21PMAT302 | Real Analysis-I | 4 | 6 | 50 | 50 | 100 |
| | III | Core-3 | 19PMAT303 | Ordinary Differential Equations | 4 | 6 | 50 | 50 | 100 |
| | III | Core-4 | 21PMAT304 | Operations Research | 4 | 6 | 50 | 50 | 100 |
| | III | Elective-1 | 21PMAT305 | Object Oriented Programming with C++/ Number Theory and Cryptography | 3 | 4 | 50 | 50 | 100 |
| | IV | Soft skill-1 | 19PGSL401 | Personality Enrichment Skills | 2 | 2 | 50 | 50 | 100 |
| **Total Credits: 21 / Total Hours per week: 30** | | | | | | | | | |
| Semester – II | III | Core-5 | 21PMAT306 | Algebra-II | 4 | 6 | 50 | 50 | 100 |
| | III | Core-6 | 19PMAT307 | Real Analysis-II | 4 | 6 | 50 | 50 | 100 |
| | III | Core-7 | 21PMAT308 | Partial Differential Equations | 4 | 5 | 50 | 50 | 100 |
| | III | Core-8 | 21PMAT309 | Probability Theory | 4 | 5 | 50 | 50 | 100 |
| | III | Elective-2 | 21PMAT310 | Practical for Programming with C++ / Difference Equations | 3 | 3 | 50 | 50 | 100 |
| | III | Extra Disciplinary Elective -1 | 21PEDE305 | Numerical Methods / Quantitative Aptitude | 3 | 3 | 50 | 50 | 100 |
| | IV | Soft skill-2 | 20PGSL403 | Work-Place Communication Skills | 2 | 2 | 50 | 50 | 100 |
| **Total Credits: 24 / Total Hours per week: 30** | | | | | | | | | |
| Semester – III | III | Core-9 | 21PMAT311 | Complex Analysis | 4 | 7 | 50 | 50 | 100 |
| | III | Core-10 | 19PMAT313 | Topology | 4 | 6 | 50 | 50 | 100 |
| | III | Core-11 | 21PMAT312 | Mechanics | 4 | 6 | 50 | 50 | 100 |
| | III | Elective-3 | 21PMAT314 | Stochastic Processes / Algebraic Theory of Numbers | 3 | 6 | 50 | 50 | 100 |
| | III | Extra Disciplinary Elective -2 | 21PEDE314 | Statistical Methods / Logical Reasoning for Competitive Exams | 3 | 3 | 50 | 50 | 100 |
| | IV | Soft skill-3 | 19PGSL403 | Self and Time Management Skill | 2 | 2 | 50 | 50 | 100 |
| | IV | | 20PINT401 | Internship | 2 | - | - | - | - |
| **Total Credits: 22 / Total Hours per week: 30** | | | | | | | | | |

**M.Sc. MATHMEMATICS**
**COURSE STRUCTURE OF 2022-2024 BATCH**

| Semester | Part | Course Component | Subject Code | Subject Name | Credits | Hours | Internal | External | Total |
|---|---|---|---|---|---|---|---|---|---|
| Semester – IV | III | Core-12 | 21PMAT315 | Calculus of Variations and Integral Equations | 4 | 5 | 50 | 50 | 100 |
| | III | Core-13 | 21PMAT316 | Differential Geometry | 4 | 5 | 50 | 50 | 100 |
| | III | Core-14 | 21PMAT317 | Functional Analysis | 4 | 5 | 50 | 50 | 100 |
| | III | Core-15 | 21PMAT318 | Project | 4 | 4 | 50 | 50 | 100 |
| | III | Elective-4 | 21PMAT319 | Graph Theory / Mathematical Statistics | 3 | 5 | 50 | 50 | 100 |
| | III | Elective-5 | 21PMAT320 | Fuzzy sets and their Applications / Algebraic Topology | 3 | 4 | 50 | 50 | 100 |
| | IV | Soft skill-4 | 19PGSL404 | Spoken and Presentation Skill | 2 | 2 | 50 | 50 | 100 |
| **Total Credits: 24 / Total Hours per week: 30** | | | | | | | | | |

# SEMESTER - I

**CORE - I**
**ALGEBRA – I**

| | | |
|---|---|---|
| **SUBJECT CODE:** 21PMAT301 | **THEORY** | **MARKS: 100** |
| **SEMESTER: I** | **CREDITS: 4** | **TOTAL HOURS: 90** |

**COURSE FRAMEWORK:**

Covers the fundamental concepts and theorems in algebraic structures.

**COURSE OUTCOMES:**

On completion of the course the students will be able to:

1. Acquire knowledge of equivalence relation on finite set, equivalence class, order of equivalence class and using it find the results about finite group and study the Sylow's theorem and the application of Sylow's theorem.
2. Analyze Direct Products, Finite Abelian Groups and Modules
3. Analyze the canonical forms, triangular forms and nilpotent transformations.
4. Demonstrate the Jordan form, rational canonical form and companion matrix of the polynomial on finite dimensional vector space V over F and linear transformation T.
5. Acquire knowledge of Trace, Transpose, Hermitian, Unitary and Normal of linear transformation, solving the problems.

**UNIT-I** **(18hrs)**

**Group Theory:** Another Counting Principle-Sylow's Theorems

**Chapter 2:** Section 2.11 & 2.12

**UNIT-II** **(18hrs)**

**Group Theory**: Direct Products-Finite Abelian Groups
**Vector Spaces and Modules**: Modules

**Chapter 2**: Sections 2.13 & 2.14,
**Chapter 4:** Section 4.5

**UNIT-III** **(18hrs)**

**Linear Transformations**: - Canonical Forms: Triangular Form.- Nilpotent Transformations.

**Chapter 6:** Sections 6.4 & 6.5

**UNIT-IV** **(18hrs)**

**Linear Transformations**: Canonical Forms: A Decomposition of V- Jordan Form - Rational Canonical Form

**Chapter 6:** Sections 6.6 & 6.7

**UNIT-V** **(18hrs)**

**Linear Transformations**: Trace and transpose - Hermitian, Unitary and Normal Transformations- Real Quadratic Forms.

**Chapter 6**: Sections 6.8, 6.10 & 6.11

**PRESCRIBED BOOK:**

I. N. Herstein. Topics in Algebra (II Edition) Wiley, 2002.

**REFERENCE BOOKS:**


1. M. Artin, Algebra, Prentice Hall of India, 1991.
2. P. B. Bhattacharya, S. K. Jain, and S.R. Nagpaul, Basic Abstract Algebra (II Edition) ` Cambridge University Press, 1997. (Indian Edition)
3. I. S. Luther and I. B. S. Passi, Algebra, Vol. I - Groups(1996); Vol. II Rings(1999), Narosa Publishing House , New Delhi
4. D. S. Dummit and R. M. Foote, Abstract Algebra, 2nd edition, Wiley, 2002.
5. N. Jacobson, Basic Algebra, Vol. I & II W. H. Freeman (1980); also published by Hindustan Publishing Company, NewDelhi.

**QUESTION PAPER PATTERN:**

| Section | Question Component | Numbers | Marks | Total |
|---|---|---|---|---|
| Section A | **Definition / Principles**<br>Answer any 10 out of 12 questions | 1-12 | 3 | 30 |
| Section B | **Short Answer**<br>Answer any 5 out of 7 questions | 13-19 | 6 | 30 |
| Section C | **Essay**<br>Answer any 4 out of 6 questions | 20-25 | 10 | 40 |
| TOTAL MARKS | | | | 100 |

**DISTRIBUTION OF QUESTIONS:**

| **Sections** | **Units** | **No. of Questions** | |
|---|---|---|---|
| | | **Theory** | **Problems** |
| Section A | Unit – 1 | 3 | - |
| | Unit – 2 | 3 | - |
| | Unit – 3 | 2 | - |
| | Unit – 4 | 2 | - |
| | Unit – 5 | 2 | - |
| Section B | Unit – 1 | 2 | - |
| | Unit – 2 | 1 | - |
| | Unit – 3 | 2 | - |
| | Unit – 4 | 1 | - |
| | Unit – 5 | 1 | - |
| Section C | Unit – 1 | 2 | - |
| | Unit – 2 | 1 | - |
| | Unit – 3 | 1 | - |
| | Unit – 4 | 1 | - |
| | Unit – 5 | 1 | - |

**CORE - II**
**REAL ANALYSIS – I**

| | | |
|---|---|---|
| **SUBJECT CODE:** 21PMAT302 | **THEORY** | **MARKS: 100** |
| **SEMESTER: I** | **CREDITS: 4** | **TOTAL HOURS: 90** |

**COURSE FRAMEWORK:**

Covers the fundamental concepts and theorems in real analysis.

**COURSE OUTCOMES:**

On completion of the course the students will be able to:

1. Understand the functions of bounded variation, a class of functions closely related to monotonic functions.
2. Apply the Riemann-Stieltjes integral and its properties in related problems.
3. Apply the Riemann integral and its properties in related problems.
4. Analyze the sequence of functions and related problems.
5. Demonstrate the pointwise convergence and uniform convergence and related problems.

**UNIT-I** **(18hrs)**

**Functions of bounded variation :** Introduction - Properties of monotonic functions - Functions of bounded variation - Total variation - Additive property of total variation - Total variation on [a, x] as a function of x - Functions of bounded variation expressed as the difference of two increasing functions - Continuous functions of bounded variation.
**Infinite Series:** Absolute and conditional convergence - Dirichlet's test and Abel's test.

**Chapter 6:** Sections 6.1 to 6.8
**Chapter 8:** Sections 8.8 & 8.15

**UNIT-II** **(18hrs)**

**The Riemann - Stieltjes Integral:** Introduction - Notation - The definition of the Riemann - Stieltjes integral - Linear Properties - Integration by parts- Change of variable in a Riemann – Stieltjes integral - Reduction to a Riemann Integral – -Euler‟s summation formula - Monotonically increasing integrators, Upper and lower integrals - Additive and linearity properties of upper and lower integrals - Riemann's condition – Comparison theorems.

**Chapter 7:** Sections 7.1 to 7.7 & 7.10 to 7.14

**UNIT-III** **(18hrs)**

**The Riemann-Stieltjes Integral :** Integrators of bounded variation-Sufficient conditions for the existence of Riemann-Stieltjes integrals-Necessary conditions for the existence of Riemann-Stieltjes integrals- Mean value theorems for Riemann-Stieltjes integrals - The integrals as a function of the interval - Second fundamental theorem of integral calculus- Change of variable in a Riemann integral-Second Mean Value Theorem for Riemann integral-Riemann-Stieltjes integrals depending on a parameter-Differentiation under the integral sign- Lebesgue's criterion for the existence of Riemann integrals.

**Chapter 7:** Sections 7.15 to 7.24 &7.26

**UNIT-IV** **(18hrs)**

**Infinite Series and infinite Products:** Multiplication of series –Cesaro summability - Infinite products.

**Sequence of Functions:** Power series - Multiplication of power series - The Taylor's series generated by a function - Bernstein's theorem - Abel's limit theorem - Tauber's theorem

**Chapter 8:** Sections 8.24 to 8.26
**Chapter 9:** Sections 9.14, 9.15, 9.19, 9.20, 9.22, 9.23

**UNIT-V** **(18hrs)**

**Sequences of Functions**: Pointwise convergence of sequences of functions - Examples of sequences of real-valued functions - Definition of uniform convergence - Uniform convergence and continuity - The Cauchy condition for uniform convergence - Uniform convergence of infinite series of functions- Uniform convergence and Riemann - Stieltjes integration – Non-uniformly Convergence sequences that can be integrated Term-by-term Integration - Uniform convergence and differentiation - Sufficient conditions for uniform convergence of a series.

**Chapter 9:** Sec 9.1 to 9.6, 9.8, 9.9, 9.10, 9.11

**PRESCRIBED BOOK:**

Tom M. Apostol: Mathematical Analysis, 2nd Edition, Narosa,1989.

**REFERENCE BOOKS:**


1. Bartle. R. G, Real Analysis, John Wiley and Sons Inc., 1976.
2. Rudin. W, Principles of Mathematical Analysis, 3rd Edition. McGraw Hill Company,New York,1976.
3. Malik. S. C, and SavitaArora. Mathematical Analysis, Wiley Eastern Limited. New Delhi, 1991.
4. Sanjay Arora and BansiLal, Introduction to Real Analysis, SatyaPrakashan, New Delhi, 1991.
5. Gelbaum. B. R, and J. Olmsted, Counter Examples in Analysis, Holden day, San Francisco,1964.
6. L. Gupta and N. R. Gupta, Principles of Real Analysis,Pearson Education, (Indian print) 2003.

**QUESTION PAPER PATTERN:**

| Section | Question Component | Numbers | Marks | Total |
|---|---|---|---|---|
| Section A | **Definition / Principles**<br>Answer any 10 out of 12 questions | 1-12 | 3 | 30 |
| Section B | **Short Answer**<br>Answer any 5 out of 7 questions | 13-19 | 6 | 30 |
| Section C | **Essay**<br>Answer any 4 out of 6 questions | 20-25 | 10 | 40 |
| TOTAL MARKS | | | | 100 |

**DISTRIBUTION OF QUESTIONS:**

| **Sections** | **Units** | **No. of Questions** | |
|---|---|---|---|
| | | **Theory** | **Problems** |
| Section A | Unit – 1 | 1 | 1 |
| | Unit – 2 | 1 | 2 |
| | Unit – 3 | 1 | 2 |
| | Unit – 4 | 1 | 1 |
| | Unit – 5 | 1 | 1 |
| Section B | Unit – 1 | 1 | - |
| | Unit – 2 | 1 | 1 |
| | Unit – 3 | 1 | - |
| | Unit – 4 | - | 2 |
| | Unit – 5 | - | 1 |
| Section C | Unit – 1 | 1 | - |
| | Unit – 2 | - | 1 |
| | Unit – 3 | 1 | 1 |
| | Unit – 4 | - | 1 |
| | Unit – 5 | 1 | - |

## CORE - III
## ORDINARY DIFFERENTIAL EQUATIONS

| | | |
|---|---|---|
| **SUBJECT CODE:** 19PMAT303 | **THEORY** | **MARKS: 100** |
| **SEMESTER: I** | **CREDITS: 4** | **TOTAL HOURS: 90** |

**COURSE FRAMEWORK:**

To understand the problem-solving technique using differential equations.

**COURSE OUTCOMES:**

On completion of the course the students will be able to:

1. Demonstrate the second order homogeneous equations-Initial value problems-Linear dependence and independence-Wronskian and a formula for Wronskian.
2. Use the knowledge acquired on the homogeneous and non-homogeneous equation of order n – Initial value problems-Annihilator method to solve non-homogeneous equation.
3. Build up the initial value problems -Existence and uniqueness theorems – Solutions to solve a non- homogeneous equation.
4. Communicate the second order equations with regular singular points –Exceptional cases – Bessel equation.
5. Apply the ODE with variable separated – Exact equation – Method of successive approximations – the Lipschitz condition – Convergence of the successive approximations and the existence theorem.

**UNIT-I** **(18 hrs)**

**Linear equations with constant coefficients:** Second order homogeneous equations-Initial value problems- Linear dependence and independence-Wronskian and a formula for Wronskian-Non-homogeneous equation of order two.

**Chapter 2:** Sections 1 to 6

**UNIT-II** **(18hrs)**

**Linear equations with constant coefficients:** Homogeneous and non-homogeneous equation of order n –Initial value problems- Annihilator method to solve non-homogeneous equation**.**

**Chapter 2:** Sections 7 to11.

**UNIT-III** **(18hrs)**

**Linear equation with variable coefficients**: Initial value problems -Existence and uniqueness theorems – Solutions to solve a non- homogeneous equation – Wronskian and linear dependence– Reduction of the order of a homogeneous equation –Homogeneous equation with analytic coefficients-The Legendre equation**.**

**Chapter** 3: Sections 1 to 8

**UNIT-IV** **(18hrs)**

**Linear equation with regular singular points:** Second order equations with regular singular points –Exceptional cases – Bessel equation.

**Chapter 4:** Sections 3, 4 ,6 ,7 & 8

**UNIT-V** **(18hrs)**

**Existence and uniqueness of solutions to first order equations:** Equation with variable separated – Exact equation – Method of successive approximations – the Lipschitz condition – Convergence of the successive approximations and the existence theorem.

**Chapter 5:** Sections 1 to 6

**PRESCRIBED TEXTBOOK:**

**E.A.Coddington, An introduction to ordinary differential equations (3rd Printing)** Prentice-Hall of India Ltd.,New Delhi, 1987.

**REFERENCE BOOKS:**


1. Williams E. Boyce and Richard C. Di Prima, Elementary differentialequations andboundary value problems,John Wiley and sons, New York,1967.
2. George F Simmons, Differential equations with applications and historicalnotes, Tata McGraw Hill, New Delhi,1974.
3. 3.N.N. Lebedev, Special functions and their applications, Prentice Hall of India, New Delhi, 1965.
4. W. T. Reid. Ordinary Differential Equations, John Wiley and Sons, New York, 1971
5. M. D. Raisinghania, Advanced Differential Equations, S.Chand & Company Ltd. New Delhi2001.

**QUESTION PAPER PATTERN:**

| Section | Question Component | Numbers | Marks | Total |
|---|---|---|---|---|
| Section A | **Definition / Principles**<br>Answer any 10 out of 12 questions | 1-12 | 3 | 30 |
| Section B | **Short Answer**<br>Answer any 5 out of 7 questions | 13-19 | 6 | 30 |
| Section C | **Essay**<br>Answer any 4 out of 6 questions | 20-25 | 10 | 40 |
| TOTAL MARKS | | | | 100 |

**DISTRIBUTION OF QUESTIONS:**

| **Sections** | **Units** | **No. of Questions** | |
|---|---|---|---|
| | | **Theory** | **Problems** |
| Section A | Unit – 1 | 1 | 1 |
| | Unit – 2 | 1 | 2 |
| | Unit – 3 | 1 | 2 |
| | Unit – 4 | 1 | 1 |
| | Unit – 5 | 1 | 1 |
| Section B | Unit – 1 | 1 | - |
| | Unit – 2 | 1 | 1 |
| | Unit – 3 | 1 | - |
| | Unit – 4 | - | 2 |
| | Unit – 5 | - | 1 |
| Section C | Unit – 1 | 1 | - |
| | Unit – 2 | - | 1 |
| | Unit – 3 | 1 | 1 |
| | Unit – 4 | - | 1 |
| | Unit – 5 | 1 | - |

## CORE - IV
## OPERATIONS RESEARCH

| | | |
|---|---|---|
| **SUBJECT CODE :** 21PMAT304 | **THEORY** | **MARKS: 100** |
| **SEMESTER: I** | **CREDITS: 4** | **TOTAL HOURS: 90** |

**COURSE FRAMEWORK:**

Finds the solution in optimization problems.

**COURSE OUTCOMES:**

On completion of the course the students will be able to:

1. Formulate linear integer programming models and Find the solution techniques using branch-and-bound algorithm and cutting plane algorithm.
2. Explain Dynamic Programming Models along with computations by recursion and applications to problem of Dimensionality.
3. Understanding the meaning of inventory control as well as various forms and functional role of inventory, use the economic order quantity (EOQ) to minimize the inventory cost, compute the reorder level (ROL).
4. Understand various components or parts of a queuing system, Identify and examine situation that general queuing problems, understand distinct among several queuing models and derive performance measures for each of them.
5. Analyze the general Nonlinear Programming algorithm, Gradient method and Quadratic Programming.

**UNIT-I** **(18hrs)**

**Integer Linear Programming:** Illustrative- Applications Integer programming algorithm – Branch and Bound algorithm – Cutting plane algorithm.

**Chapter 9:** Sections. 9.1 & 9.2

**UNIT-II** **(18 hrs)**

**Deterministic Dynamic Programming:** Recursive nature of computation in DP – Forward and Backward recursion. Selected DP application – Cargo Loading model – Work force size model – Problem of dimensionality.

**Chapter 12:** Sections 12.1, 12.2, 12.3.1, 12.3.2, 12.4.

**UNIT-III** **(18 hrs)**

**Deterministic Inventory Control Models:** General inventory model – static EOQ model – classical EOQ model – EOQ with price breaks – Multi item EOQ with storage limitation.

**Chapter 13:** Sections 13.1 and 13.3

**UNIT-IV** **(18 hrs)**

**Queueing System**s: Elements of a queueing model – Specialized Poisson Queues – Steady state measures of performance – Single server models – Multiple server models.

**Chapter 18:** Sections. 18.2, 18.6.1, 18.6.2, 18.6.3.

**UNIT-V** **(18 hrs)**

**Nonlinear programming algorithm:** Unconstrained algorithm – Direct search method – Gradient method – Constrained algorithm – Separable programming – Quadratic programming.

**Chapter 21:** Sections. 21.1, 21.2: 21.2.1, and 21.2.2.

**PRESCRIBED TEXTBOOK:**

Operations Research An Introduction by Hamdy A.TAHA, Ninth edition.

**REFERENCE BOOKS:**


1.J.K. Sharma, Operations Research Theory and Applications 5th Edition ,Macmillon Publishers India Ltd 2013

2.F.S. Hiller and J.Lieberman -,Introduction to Operations Research (7th Edition), Tata McGraw Hill Publishing Company, New Delhui, 2001.

3. Beightler. C, D.Phillips, B. Wilde ,Foundations of Optimization (2nd Edition) Prentice Hall Pvt Ltd., New York, 1979

4. Bazaraa, M.S; J.J.Jarvis, H.D.Sharall , Linear Programming and Network flow, John Wiley and sons, New York 1990.

5. Gross, D and C.M.Harris, Fundamentals of Queueing Theory, (3rd Edition), Wiley and Sons, New York, 1998.

**QUESTION PAPER PATTERN:**

| Section | Question Component | Numbers | Marks | Total |
|---|---|---|---|---|
| Section A | **Definition / Principles**<br>Answer any 10 out of 12 questions | 1-12 | 3 | 30 |
| Section B | **Short Answer**<br>Answer any 5 out of 7 questions | 13-19 | 6 | 30 |
| Section C | **Essay**<br>Answer any 4 out of 6 questions | 20-25 | 10 | 40 |
| TOTAL MARKS | | | | 100 |

**DISTRIBUTION OF QUESTIONS:**

| **Sections** | **Units** | **No. of Questions** | |
|---|---|---|---|
| | | **Theory** | **Problems** |
| Section A | Unit – 1 | 2 | - |
| | Unit – 2 | 2 | - |
| | Unit – 3 | 3 | - |
| | Unit – 4 | 2 | - |
| | Unit – 5 | 3 | - |
| Section B | Unit – 1 | 1 | - |
| | Unit – 2 | 1 | - |
| | Unit – 3 | 1 | 1 |
| | Unit – 4 | - | 1 |
| | Unit – 5 | 1 | 1 |
| Section C | Unit – 1 | - | 1 |
| | Unit – 2 | - | 1 |
| | Unit – 3 | 1 | - |
| | Unit – 4 | 1 | - |
| | Unit – 5 | 1 | 1 |

## ELECTIVE – I

### Option - I

### OBJECT ORIENTED PROGRAMMING WITH C++

| | | |
|---|---|---|
| **SUBJECT CODE:** 21PMAT305 | **THEORY** | **MARKS: 100** |
| **SEMESTER: I** | **CREDITS: 3** | **TOTAL HOURS: 60** |

**COURSE FRAMEWORK:**

Develops the ability to analyze a problem and develop an algorithm to solve it using C++Programming.

**COURSE OUTCOMES:**

On completion of the course the students will be able to:

1. Outline the essential Structures, Functions and Function Overloading of C++ Programming Language.
2. Understand Classes, Objects, Program with C++, Static Members, Objects as Arguments, Friend Functions and Returning Objects.
3. Elaborate Constructors, Destructors, Multiple Constructors in a Class and Rules for Overloading Operators.
4. Explain the concepts of Inheritance, Pointers, Virtual Functions and Polymorphism.
5. Describe Managing Console I/O Operations, Classes for File Stream Operations and File Modes.

**UNIT-I** **(12 hrs)**

**Principles of object oriented programming:** Basic concepts of object oriented programming.
**Beginning with C++ :** Structure of C++ Program.
**Tokens, Expressions and Control Structure :** Reference Variables- Operators – Manipulators – Expressions and their types -Control Structures
**Functions in C++:** Main Function – Function Prototyping- Default Arguments Function Overloading.

**Chapter 1:** Section 1.5.
**Chapter 2:** Section 2.6.
**Chapter 3:** Sections 3.12, 3.13, 3.17, 3.19 & 3.24.
**Chapter 4:** Sections 4.2, 4.3, 4.7 & 4.9.

**UNIT-II** **(12 hrs)**

**Classes and Objects:** Specifying a Class – Defining Member Functions – A C++ Program with Class – Static Data Members– Static Member Functions – Arrays of Objects – Objects as Function – Arguments – Friendly Functions – Returning Objects.

**Chapter 5:** Sections 5.3, 5.4, 5.5, 5.11, 5.12, 5.13, 5.14, 5.15 & 5.16

**UNIT-III** **(12 hrs)**

**Constructors and Destructors:** Parameterized Constructors – Multiple Constructors in a Class – Copy Constructors – Destructors

**Operator Overloading and Type Conversions:** Defining Operator Overloading – Overloading Unary Operators – Overloading Binary Operators – Using Friend Function – Rules for Overloading Operators

**Chapter 6:** Sections 6.3, 6.4, 6.7, 6.11
**Chapter 7:** Sections 7.2, 7.3, 7.4, 7.5, 7.7

**UNIT-IV** **(12 hrs)**

**Inheritance:** Defining Derived Classes – Single Inheritance – Multilevel Inheritance – Multiple inheritance – Virtual Base Classes

**Pointers**: Pointers to Objects – this pointer – Pointer to Derived Classes – Virtual Functions and Polymorphism – Pure Virtual Function

**Chapter 8:** Sections 8.2, 8.3, 8.5, 8.6, 8.9
**Chapter 9:** Sections 9.3, 9.4, 9.5, 9.6, 9.7

**UNIT-V** **(12 hrs)**

**Managing Console I/O Operations:** C++ Streams – C++ Stream Classes –

**Working with Files:** Classes for File Stream Operations – Opening and Closing a File – Detecting End-of- File – File Modes.

**Chapter 10:** Sections 10.2 & 10.3
**Chapter 11:** Sections 11.2, 11.3, 11.4 & 11.5

**PRESCRIBED BOOK:**

1. Balagurusamy, Object Oriented Programming with C++, Tata McGraw Hill, New Delhi, 1999.

**REFERENCE BOOKS:**

1. Ravichandran, Programming with C++, Tata McGraw Hill, New Delhi, 1996

**QUESTION PAPER PATTERN:**

| Section | Question Component | Numbers | Marks | Total |
|---|---|---|---|---|
| Section A | **Definition / Principles**<br>Answer any 10 out of 12 questions | 1-12 | 3 | 30 |
| Section B | **Short Answer**<br>Answer any 5 out of 7 questions | 13-19 | 6 | 30 |
| Section C | **Essay**<br>Answer any 4 out of 6 questions | 20-25 | 10 | 40 |
| TOTAL MARKS | | | | 100 |

**DISTRIBUTION OF QUESTIONS:**

| **Sections** | **Units** | **No. of Questions** | |
|---|---|---|---|
| | | **Theory** | **Problems** |
| Section A | Unit – 1 | 3 | - |
| | Unit – 2 | 3 | - |
| | Unit – 3 | 2 | - |
| | Unit – 4 | 2 | - |
| | Unit – 5 | 2 | - |
| Section B | Unit – 1 | 2 | - |
| | Unit – 2 | 1 | - |
| | Unit – 3 | 1 | - |
| | Unit – 4 | 2 | - |
| | Unit – 5 | 1 | - |
| Section C | Unit – 1 | 2 | - |
| | Unit – 2 | 1 | - |
| | Unit – 3 | 1 | - |
| | Unit – 4 | 1 | - |
| | Unit – 5 | 1 | - |

## ELECTIVE – I
## Option - II
## NUMBER THEORY AND CRYPTOGRAPHY

| | | |
|---|---|---|
| **SUBJECT CODE:** 21PMAT305 | **THEORY** | **MARKS: 100** |
| **SEMESTER: I** | **CREDITS: 3** | **TOTAL HOURS: 60** |

**COURSE FRAMEWORK:**

Covers dynamic transform in number theory and cryptography technique.

**COURSE OUTCOMES:**

On completion of the course the students will be able to:

1. Analyze about Elementary Number Theory, Time Estimates for doing arithmetic,divisibility and Euclidean algorithm, Congruence, Application to factoring and related problems.
2. Study about Introduction to Classical Crypto systems, some simple crypto systems, Enciphering matrices DES and related problems.
3. Acquire knowledge on Finite Fields, Quadratic Residues, Reciprocity and relate problems.
4. Understand the Public Key Cryptography, The idea of public key Cryptography, RSA, Discrete log, Knapsack, Zero-knowledge protocols & oblivious transfer and related problems.
5. Elaborate about the Primality, Factoring, Elliptic curves and Elliptic curve crypto systems, Pseudoprimes, The Rho method, Fermat factorization and factor bases, The Continued fraction method, uniform convergence and related problems.

**UNIT-I** **(12 hrs)**

**Elementary Number Theory:** Time Estimates for doing arithmetic – divisibility and Euclidean algorithm

**Chapter 1:** Sections 1 & 2

**UNIT-II** **(12 hrs)**

**Elementary Number Theory:** Congruences – Some applications to factoring

**Chapter 1:** Sections 3 & 4

**UNIT-III** **(12 hrs)**

**Finite Fields and Quadratic Residues:** Finite Fields-Quadratic residues and reciprocity.

**Chapter 2:** Sections 1 & 2

**UNIT-IV** **(12 hrs)**

**Cryptography:** Some simple cryptosystems Enciphering matrices

**Chapter 3:** Sections 1 and 2.

**UNIT-V** **(12 hrs)**

**Public Key:** Public Key Cryptography – RSA

**Chapter 4:** Sections 1 and 2

**PRESCRIBED TEXTBOOK:**

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

**REFERENCE BOOKS:**


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


**QUESTION PAPER PATTERN:**

| Section | Question Component | Numbers | Marks | Total |
|---|---|---|---|---|
| Section A | **Definition / Principles** Answer any 10 out of 12 questions | 1-12 | 3 | 30 |
| Section B | **Short Answer** Answer any 5 out of 7 questions | 13-19 | 6 | 30 |
| Section C | **Essay** Answer any 4 out of 6 questions | 20-25 | 10 | 40 |
| TOTAL MARKS | | | | 100 |

**DISTRIBUTION OF QUESTIONS:**

| **Sections** | **Units** | **No. of Questions** | |
|---|---|---|---|
| | | **Theory** | **Problems** |
| Section A | Unit – 1 | 1 | 2 |
| | Unit – 2 | 1 | 1 |
| | Unit – 3 | 2 | 1 |
| | Unit – 4 | 2 | - |
| | Unit – 5 | 2 | - |
| Section B | Unit – 1 | 1 | 1 |
| | Unit – 2 | - | 1 |
| | Unit – 3 | 2 | - |
| | Unit – 4 | 1 | - |
| | Unit – 5 | 1 | - |
| Section C | Unit – 1 | 2 | - |
| | Unit – 2 | 1 | - |
| | Unit – 3 | 1 | - |
| | Unit – 4 | 1 | - |
| | Unit – 5 | 1 | - |

# SEMESTER-II

## CORE- V
## ALGEBRA – II

| | | |
|---|---|---|
| **SUBJECT CODE:** 21PMAT306 | **THEORY** | **MARKS: 100** |
| **SEMESTER: II** | **CREDITS: 4** | **TOTAL HOURS: 90** |

**COURSE FRAMEWORK:**

Covers the basic concepts and theorems in extension fields.

**COURSE OUTCOMES:**

On completion of the course the students will be able to:

1. Establish the relation of one field to another and the degree of extension field.
2. Determine the root of a given polynomial on extension field K over F.
3. Study the Galois group associated with a polynomial and the relationship between roots of a polynomials and its Galois group.
4. Determine all possible finite fields and many of their important properties and derivation of Wedderburn's theorem, Finite division rings on finite fields.
5. Contemplate the solvability by radicals which helps to find the Galois group of irreducible polynomials over the Rationals and to derive the theorem of Frobenius.

**UNIT-I** **(18hrs)**

**Fields:** Extension fields -The Transcendence of e.

**Chapter 5:** Sections 5.1 & 5.2

**UNIT-II** **(18hrs)**

**Fields:** Roots of Polynomials- More about roots

**Chapter 5:** Sections 5.3 & 5.5

**UNIT-III** **(18hrs)**

**Fields:** Elements of Galois theory

**Chapter 5:** Section 5.6

**UNIT-IV** **(18hrs)**

**Selected Topics:** Finite fields - Wedderburn's theorem on finite division rings

**Chapter 7:** Sections 7.1 & 7.2 (Theorem 7.2.1 only)

**UNIT-V** **(18hrs)**

**Fields:** Solvability by radicals–Galois groups over the rationals.

**Selected Topics:** A theorem of Frobenius.

**Chapter 5:** Sections 5.7 & 5.8
**Chapter 7:** Sections 7.3

**PRESCRIBED TEXTBOOK:**

I. N. Herstein. Topics in Algebra (II Edition) Wiley 2002

**REFERENCE BOOKS:**


1. M. Artin, Algebra, Prentice Hall of India,1991.
2. P. B. Bhattacharya, S. K. Jain, and S. R. Nagpaul, Basic Abstract Algebra (II Edition) Cambridge University Press, 1997. (Indian Edition)
3. S. Luther and I. B. S. Passi, Algebra, Vol. I - Groups(1996); Vol. II Rings, (1999) Narosa Publishing House , New Delhi.
4. S. Dummit and R. M. Foote, Abstract Algebra, 2nd edition, Wiley,2002.
5. N. Jacobson, Basic Algebra, Vol. I & II Hindustan Publishing Company, New Delhi.

**QUESTION PAPER PATTERN:**

| Section | Question Component | Numbers | Marks | Total |
|---|---|---|---|---|
| Section A | **Definition / Principles**<br>Answer any 10 out of 12 questions | 1-12 | 3 | 30 |
| Section B | **Short Answer**<br>Answer any 5 out of 7 questions | 13-19 | 6 | 30 |
| Section C | **Essay**<br>Answer any 4 out of 6 questions | 20-25 | 10 | 40 |
| TOTAL MARKS | | | | 100 |

**DISTRIBUTION OF QUESTIONS:**

| **Sections** | **Units** | **No. of Questions** | |
|---|---|---|---|
| | | **Theory** | **Problems** |
| Section A | Unit – 1 | 1 | 1 |
| | Unit – 2 | 3 | - |
| | Unit – 3 | 3 | - |
| | Unit – 4 | 2 | - |
| | Unit – 5 | 2 | - |
| Section B | Unit – 1 | 1 | - |
| | Unit – 2 | 2 | |
| | Unit – 3 | 2 | - |
| | Unit – 4 | 1 | - |
| | Unit – 5 | 1 | 1 |
| Section C | Unit – 1 | 2 | - |
| | Unit – 2 | 1 | - |
| | Unit – 3 | 1 | - |
| | Unit – 4 | 1 | - |
| | Unit – 5 | 1 | - |

## CORE VI
## REAL ANALYSIS – II

| | | |
|---|---|---|
| **SUBJECT CODE:** 19PMAT307 | **THEORY** | **MARKS: 100** |
| **SEMESTER: II** | **CREDITS: 4** | **TOTAL HOURS: 90** |

**COURSE FRAMEWORK:**

Analyzes the concepts in extended real numbers.

**COURSE OUTCOMES:**

On completion of the course the students will be able to'

1. Understand a class of measurable sets on the real line, the measurable functions and related problems.
2. Study the approximation to measurable sets by intervals or by open sets,an approximation to the integral of a measurable function and compare the Lebesgue integrals and Riemann integrals.
3. Compute the Fourier series and Fourier integrals and its related problems.
4. Study the Directional derivative and the total derivative and related problems.
5. Acquire knowledge on Implicit functions, Extremum problems and related properties.

**UNIT-I** **(18hrs)**

**Measure on the Real line:** Lebesgue Outer Measure - Measurable sets - Regularity - Measurable Functions - Borel and Lebesgue Measurability

**Chapter 2:** Sections 2.1 to 2.5 of Book [1]

**UNIT-II** **(18hrs)**

**Integration of Functions of a Real variable:** Integration of Non- negative functions - The General Integral - Riemann and Lebesgue Integrals

**Chapter 3:** Sections 3.1,3.2 & 3.4 of Book [1]

**UNIT-III** **(18hrs)**

**Fourier Series and Fourier Integrals:** Introduction - Orthogonal system of functions - The theorem on best approximation - The Fourier series of a function relative to an orthonormal system - Properties of Fourier Coefficients - The Riesz-Fischer Theorem - The convergence and representation problems in for trigonometric series - The Riemann - Lebesgue Lemma - The Dirichlet Integrals - An integral representation for the partial sums of Fourier series - Riemann's localization theorem - Sufficient conditions for convergence of a Fourier series at a particular point – Cesarosummability of Fourier series- Consequences of Fejes's theorem - The Weierstrass approximation theorem

**Chapter 11:** Sections 11.1 to 11.15 of Book [2]

**UNIT-IV** **(18hrs)**

**Multivariable Differential Calculus:** Introduction - The Directional derivative - Directional derivative and continuity- The total derivative - The total derivative expressed in terms of partial derivatives - The matrix of linear function - The Jacobian matrix - The chain rule - Matrix form of chain rule - The mean - value theorem for differentiable functions - A sufficient condition for differentiability - A sufficient condition for equality of mixed partial derivatives - Taylor's theorem for functions of Rn to R1

**Chapter 12:** Section 12.1 to 12.14 of Book [2]

**UNIT-V** **(18hrs)**

**Implicit Functions and Extremum Problems:** Functions with non-zero Jacobian determinants – The inverse function theorem-The Implicit function theorem-Extrema of real valued functions of severable variables-Extremum problems with side conditions.

**Chapter 13:** Sections 13.1 to 13.7 of Book [2]

**PRESCRIBED BOOKS:**


1. G. de Barra, Measure Theory and Integration, New Age International,2003
2. Tom M. Apostol : Mathematical Analysis, 2nd Edition, Narosa 1989


**REFERENCE BOOKS:**


1. Burkill,J.C. The Lebesgue Integral, Cambridge University Press,1951.
2. Munroe,M.E. Measure and Integration. Addison-Wesley,Mass.1971.
3. Royden,H.L.Real Analysis, Macmillan Pub. Company, New York,1988.
4. Rudin, W. Principles of Mathematical Analysis, McGraw Hill Company, New York, 1979.
5. Malik,S.C. and SavitaArora. Mathematical Analysis, Wiley Eastern Limited. New Delhi,1991.

**QUESTION PAPER PATTERN:**

| Section | Question Component | Numbers | Marks | Total |
|---|---|---|---|---|
| Section A | **Definition / Principles**<br>Answer any 10 out of 12 questions | 1-12 | 3 | 30 |
| Section B | **Short Answer**<br>Answer any 5 out of 7 questions | 13-19 | 6 | 30 |
| Section C | **Essay**<br>Answer any 4 out of 6 questions | 20-25 | 10 | 40 |
| TOTAL MARKS | | | | 100 |

**DISTRIBUTION OF QUESTIONS:**

| **Sections** | **Units** | **No. of Questions** | |
|---|---|---|---|
| | | **Theory** | **Problems** |
| Section A | Unit – 1 | 2 | - |
| | Unit – 2 | 3 | - |
| | Unit – 3 | 2 | - |
| | Unit – 4 | 3 | - |
| | Unit – 5 | 2 | - |
| Section B | Unit – 1 | 1 | 1 |
| | Unit – 2 | 1 | 1 |
| | Unit – 3 | 1 | - |
| | Unit – 4 | 1 | - |
| | Unit – 5 | 1 | - |
| Section C | Unit – 1 | 1 | - |
| | Unit – 2 | 2 | - |
| | Unit – 3 | 1 | - |
| | Unit – 4 | 1 | - |
| | Unit – 5 | 1 | - |

## CORE- VII
## PARTIAL DIFFERENTIAL EQUATIONS

| | | |
|---|---|---|
| **SUBJECT CODE:** 21PMAT308 | **THEORY** | **MARKS: 100** |
| **SEMESTER: II** | **CREDITS: 4** | **TOTAL HOURS: 75** |

**COURSE FRAMEWORK:**

Develops the problem-solving technique using Partial Differential Equations.

**COURSE OUTCOMES:**

On completion of the course the students will be able to

1. Demonstrate the comprehensive knowledge to classification of Second Order PDE – Canonical Forms.
2. Recognize the importance of Occurrence of the Laplace and Poisson Equations.
3. Plan and execute the Occurrence of the Diffusion Equation –Boundary Conditions and problems.
4. Apply the Occurrence of the Wave Equation – Derivation of One-dimensional WaveEquation – Solution of One-dimensional Wave Equation by Canonical Reduction – The Initial Value Problem.
5. Core competencies the Green's function for Laplace equation – the methods of Images –the eigen function method.

**UNIT-I** **(15hrs)**

**Fundamental Concepts:** Introduction – Classification of Second Order PDE – Canonical Forms: Canonical Form for Hyperbolic Equation, Canonical Form for Parabolic Equation, Canonical Form for Elliptic Equation.

**Chapter 1:** Section: 1.1 to 1.3

**UNIT-II** **(15hrs)**

**Elliptic Differential Equations:** Occurrence of the Laplace and Poisson Equations: Derivation of Laplace Equation, Derivation of Poisson Equation. Boundary Value Problem (BVPs) – Some important Mathematical tools - Separation of Variables – Dirichlet Problem for a Rectangle - The Neumann Problem for a rectangle - Interior Dirichlet Problem for a Circle – Exterior Dirichlet Problem for a Circle– Interior Neumann Problem for a Circle.

**Chapter 2:** Section: 2.1 to 2.3, 2.5 to 2.10

**UNIT-III** **(15hrs)**

**Parabolic Differential Equations:** Occurrence of The Diffusion Equation –Boundary Conditions – Elementary Solutions of the Diffusion Equation – Dirac Delta Function – Separation of Variables Method.

**Chapter 3:** Section: 3.1 to 3.5

**UNIT-IV** **(15hrs)**

**Hyperbolic Differential Equations:** Occurrence of the Wave Equation – Derivation of One-dimensional Wave Equation – Solution of One-dimensional Wave Equation by Canonical Reduction – The Initial Value Problem; D'Alembert's Solution – Vibrating String : Variables Separable Solution.

**Chapter 4:** Section: 4.1 to 4.5

**UNIT-V** **(15hrs)**

**Green's Function:** Introduction- Green's function for Laplace equation – the methods of Images – the eigenfunction method – Green's function for the wave equation: Helmholtz theorem.

**Chapter 5:** Section: 5.1.to 5.5.

**PRESCRIBED BOOK:**

Introduction to Partial Differential Equations by K. Sankara Rao , Third Edition, PHI Learning Private Limited.

**REFERENCE BOOKS:**


1. R.C Mc.Owen, Partial Differential Equations, II ed., Pearson Education. New Delhi,2005.
2. I.N.Sneddon, Elements of Partial Differential Equations, McGraw Hil, News Delhi,1983.
3. R. Dennemeyer, Introduction to Partial Differential Equations and BoundryValue Problems, McGraw Hill, New York,1968.
4. T.Amarnath, Partial Differential Equations, NarosapublishingHouse

**QUESTION PAPER PATTERN:**

| Section | Question Component | Numbers | Marks | Total |
|---|---|---|---|---|
| Section A | **Definition / Principles**<br>Answer any 10 out of 12 questions | 1-12 | 3 | 30 |
| Section B | **Short Answer**<br>Answer any 5 out of 7 questions | 13-19 | 6 | 30 |
| Section C | **Essay**<br>Answer any 4 out of 6 questions | 20-25 | 10 | 40 |
| TOTAL MARKS | | | | 100 |

**DISTRIBUTION OF QUESTIONS:**

| **Sections** | **Units** | **No. of Questions** | |
|---|---|---|---|
| | | **Theory** | **Problems** |
| Section A | Unit – 1 | 1 | 1 |
| | Unit – 2 | 1 | 1 |
| | Unit – 3 | 2 | 1 |
| | Unit – 4 | 2 | 1 |
| | Unit – 5 | 1 | 1 |
| Section B | Unit – 1 | - | 1 |
| | Unit – 2 | 1 | 1 |
| | Unit – 3 | - | 1 |
| | Unit – 4 | 1 | 1 |
| | Unit – 5 | - | 1 |
| Section C | Unit – 1 | - | 1 |
| | Unit – 2 | 1 | 1 |
| | Unit – 3 | - | 1 |
| | Unit – 4 | - | 1 |
| | Unit – 5 | - | 1 |

## CORE –VIII
## PROBABILITY THEORY

| | | |
|---|---|---|
| **SUBJECT CODE:** 21PMAT309 | **THEORY** | **MARKS: 100** |
| **SEMESTER: II** | **CREDITS: 4** | **TOTAL HOURS: 75** |

**COURSE FRAMEWORK:**

Covers an elaborate study in probability theory.

**COURSE OUTCOMES:**

On completion of the course the students will be able to

1. Knowledge on Random Events, Random Variables Distributions and DistributionFunctions.
2. Recognize the importance of Parameters, Order Parameters of the Distribution and Twotypes of Regression.
3. Apply Characteristic Functions and its Properties.
4. Build up on various Probability Distributions.
5. Execute on Limit Theorems and Laws of Large Numbers.

**UNIT-I** **(15hrs)**

**Random Events and Random Variables:** Preliminary remarks-Random events and operations performed on them- Probability axioms – Application of Combinatorial formulae for computing probabilities – Conditional probability– Bayes Theorem – Independent events
**Random Variables:** Concepts of a random variable- Distribution Function –Random variables –Functions of random variable- Multi dimensional random variable- Marginal Distribution – Conditional Distribution – Independent random variables – Functions of Multidimensional random variables.

**Chapter 1:** Sections 1.1 to 1.7
**Chapter 2:** Sections 2.1 to 2.9

**UNIT-II** **(15hrs)**

**Parameters of the Distribution:** Expected values- Moments – The Chebyshev Inequality – Absolute moments – Order parameters – Moments of random vectors.

**Chapter 3:** Sections 3.1 to 3.6

**UNIT-III** **(15hrs)**

**Characteristic functions:** Properties of characteristic functions – Characteristic functions and moments – Semi-Invariants – Characteristic function of the sum of the independent random variables– Determination of distribution function by the Characteristic function– Characteristic function of multidimensional random vectors.

**Chapter 4:** Sections 4.1 to 4.6

**UNIT-IV** **(15hrs)**

**Some Probability distributions:** One point and two point distribution –Binomial distribution – Polya and Hypergeometric distribution – Poisson (discrete) distributions – Uniform – normal - gamma distributions.

**Chapter 5:** Section 5.1 to 5.8

**UNIT-V** **(15hrs)**

**Limit Theorems :** Preliminary remarks- Stochastic convergence – Bernaulli law of large numbers – Convergence of sequence of distribution functions – Levy-Cramer Theorems – de Moivre-Laplace Theorem – Poisson, Chebyshev, Khintchine Weak law of large numbers – Lindberg Theorem- Lapunov Theorem

**Chapter 6:** Sections 6.1 to 6.4, 6.6 to 6.9

**PRESCRIBED TEXTBOOK:**

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

**REFERENCE BOOKS:**


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

**QUESTION PAPER PATTERN:**

| Section | Question Component | Numbers | Marks | Total |
|---|---|---|---|---|
| Section A | **Definition / Principles**<br>Answer any 10 out of 12 questions | 1-12 | 3 | 30 |
| Section B | **Short Answer**<br>Answer any 5 out of 7 questions | 13-19 | 6 | 30 |
| Section C | **Essay**<br>Answer any 4 out of 6 questions | 20-25 | 10 | 40 |
| TOTAL MARKS | | | | 100 |

**DISTRIBUTION OF QUESTIONS:**

| **Sections** | **Units** | **No. of Questions** | |
|---|---|---|---|
| | | **Theory** | **Problems** |
| Section A | Unit – 1 | 2 | 1 |
| | Unit – 2 | 1 | 1 |
| | Unit – 3 | 1 | 1 |
| | Unit – 4 | 2 | - |
| | Unit – 5 | 3 | - |
| Section B | Unit – 1 | 1 | - |
| | Unit – 2 | 1 | 1 |
| | Unit – 3 | 1 | 1 |
| | Unit – 4 | 1 | - |
| | Unit – 5 | 1 | - |
| Section C | Unit – 1 | 1 | - |
| | Unit – 2 | 1 | - |
| | Unit – 3 | 1 | - |
| | Unit – 4 | 1 | - |
| | Unit – 5 | 2 | - |

## ELECTIVE – II
## Option – I
## PRACTICAL FOR PROGRAMMING WITH C++

| | | |
|---|---|---|
| **SUBJECT CODE:** 21PMAT310 | **PRACTICAL** | **MARKS: 100** |
| **SEMESTER: II** | **CREDITS: 3** | **TOTAL HOURS: 45** |

**COURSE FRAMEWORK:**

This course will assist students in developing an understanding of how to write a programme to implement a given algorithm. Additionally, this course will assist them in selecting data structures and methods for designing algorithms that affect programme performance. Furthermore, they will learn how to solve mathematical problems using C++ programmes and will write programmes to solve a variety of problems.

**COURSE OUTCOMES:**

On completion of the course the students will be able to

1. Calculate arithmetic operations of numbers in programming language.
2. Enumerate Fibonacci series, Armstrong numbers in programming.
3. Elaborate Constructors, Destructors in C++ programming.
4. Use the Constructors overloading, Destructors overloading in C++ programming.
5. Implement multiple and multilevel inheritance in C++.

1. C++ program to display prime numbers in a given range.
2. C++ program to find the sum of cubes of odd numbers up to n.
3. C++ program to find the sum of cubes of even numbers up to n.
4. C++ program to check whether the given number is Armstrong or not.
5. C++ program for finding factorial of a number using function.
6. C++ program for displaying Fibonacci series using function.
7. C++ program for implementation of class and object.
8. C++ program for implementation of function overloading.
9. C++ program for implementation of constructor
10. C++ program for implementation of destructor
11. C++ program for implementation of constructor overloading.
12. C++ program to add two numbers using operator overloading.
13. C++ program for implementation of single inheritance
14. C++ program for implementation of multiple inheritance
15. C++ program for implementation of multilevel inheritance.

**PRESCRIBED TEXTBOOK:**

E.Balagurusamy, Object Oriented Programming with C++,Tata McGraw Hill, New Delhi, 2006.

**REFERENCE BOOK:**

Ravichandran, Programming with C++, Tata McGraw Hill, New Delhi, 1996

**QUESTION PAPER PATTERN:**

| Question Component | Marks | Total Marks |
|---|---|---|
| Write any 2 out of 4 programs | 50 each | 100 |

**ELECTIVE- II**
**Option-II**
**DIFFERENCE EQUATIONS**

| | | |
|---|---|---|
| **SUBJECT CODE:** 21PMAT310 | **THEORY** | **MARKS: 100** |
| **SEMESTER: II** | **CREDITS: 3** | **TOTAL HOURS: 45** |

**COURSE FRAMEWORK:**

Covers the mathematical foundations of numerical methods, with an emphasis on finite difference and Z-transform, which are used to solve difference equations.

**COURSE OUTCOMES:**

On completion of the course the students will be able to:

1. Explain the Difference Calculus, First order equations, and General results for linear equation with solving linear equation.
2. Analyze the Equations with variable coefficients - Nonlinear equations that can be linearized.
3. Apply the z - transform and solving the linear difference equation using z - transform.
4. Compute the problems in second-order linear equation, Sturmian Theory, and Green's function.
5. Explain the concept of Disconjugacy, Riccati equation, and Oscillation.

**Unit I** **(9 hrs)**

**Difference Calculus:** The Difference Operator-Summation Generating - Functions and Approximate Summation.

**Linear Difference Equations**: First order equations - General results for linear equation – Solving linear equation.

**Chapter-2:** Sections 2.1 to 2.3
**Chapter-3:** Sections 3.1 to 3.3

**Unit II** **(9 hrs)**

**Linear Difference Equations:** Equations with variable coefficients - Nonlinear equations that can be linearized.

**Chapter-3:** Sections 3.5, 3.6

**Unit III** **(9 hrs)**

**Linear Difference Equations**: The z - transform - solving linear difference equation using z - transform.

**Chapter-3**: Sections 3.7

**Unit IV** **(9 hrs)**

**The Self-Adjoint Second Order Linear Equation**: Second order linear equation - Sturmian Theory - Green's function.

**Chapter-6:** Sections 6.1 to 6.3

**Unit V** **(9 hrs)**

**The Self-Adjoint Second Order Linear Equation:** Disconjugacy - Riccati equation - Oscillation.

**Chapter-6:** Sections 6.4 to 6.6

**PRESCRIBED TEXTBOOK:**

W.G. Kelly and A.C. Petersan, Difference Equations: An introduction with Applications Acad. New York, 1991.

**REFERENCE BOOKS:**

1.S. Elayadi, An Introduction to Difference Equations, Springer New York 2005.

2. R.P. Agarwal Difference Equations and Inequalities, Marsel Dekker, New York, 2000.

**QUESTION PAPER PATTERN:**

| Section | Question Component | Numbers | Marks | Total |
|---|---|---|---|---|
| Section A | **Definition / Principles**<br>Answer any 10 out of 12 questions | 1-12 | 3 | 30 |
| Section B | **Short Answer**<br>Answer any 5 out of 7 questions | 13-19 | 6 | 30 |
| Section C | **Essay**<br>Answer any 4 out of 6 questions | 20-25 | 10 | 40 |
| TOTAL MARKS | | | | 100 |

**DISTRIBUTION OF QUESTIONS:**

| **Sections** | **Units** | **No. of Questions** | |
|---|---|---|---|
| | | **Theory** | **Problems** |
| Section A | Unit – 1 | 2 | 1 |
| | Unit – 2 | 2 | 1 |
| | Unit – 3 | 1 | 1 |
| | Unit – 4 | 1 | 1 |
| | Unit – 5 | 1 | 1 |
| Section B | Unit – 1 | 1 | 1 |
| | Unit – 2 | 1 | - |
| | Unit – 3 | 1 | - |
| | Unit – 4 | 1 | - |
| | Unit – 5 | 1 | 1 |
| Section C | Unit – 1 | 1 | 1 |
| | Unit – 2 | 1 | - |
| | Unit – 3 | 1 | - |
| | Unit – 4 | 1 | - |
| | Unit – 5 | 1 | - |

**EXTRA DISCIPLINARY ELECTIVE- I**
**Option - I**
**NUMERICAL METHODS**

| | | |
|---|---|---|
| **SUBJECT CODE:** 21PEDE305 | **THEORY** | **MARKS: 100** |
| **SEMESTER: II** | **CREDITS: 3** | **TOTAL HOURS: 45** |

**COURSE FRAMEWORK:**

Introduction to Interpolation Formulae and Numerical solutions of Ordinary Differential Equations.

**COURSE OUTCOMES:**

On completion of the course the students will be able to:

1. Apply Central difference interpolation formulae
2. Apply Lagrange's Interpolation formulae.
3. Apply Taylor's series Method and Picard's Method.
4. Relate Euler's method and Modified Euler's Method.
5. Find solutions of Ordinary Differential Equations

**UNIT-I** **(9hrs)**

**Interpolation:** Central difference interpolation formulae (except Laplace Everett's formulae)

**Chapter 7:** Section 7.2

**UNIT-II** **(9hrs)**

**Interpolation with unequal intervals**: Lagrange's Interpolation formulae - Divided difference

**Chapter 7:** Sections 7.3 & 7.4

**UNIT-III** **(9hrs)**

**Numerical solutions of Ordinary differential equations:** Taylor's series Method - Picard's Method

**Chapter 10:** Sections 10.1 & 10.2

**UNIT-IV** **(9hrs)**

**Numerical solutions of Ordinary differential equations:** Euler's method - Modified Euler's Method

**Chapter 10:** Sections 10.3

**UNIT-V** **(9hrs)**

**Numerical solutions of Ordinary differential equations :** Runge-Kutta Method -Milne's Method

**Chapter 10:** Sections 10.4 & 10.6

**PRESCRIBED TEXTBOOK:**

S. Arumugam, A. Thangapandi isaac, A. Somasundaram, Numerical Methods, SCITECH Publications (India) Pvt Ltd.2002.

**REFERENCE BOOKS:**


1. T. Veerarajan, T. Ramachandran, Numerical Methods, Tata McGraw-Hill Pvt Ltd.2006.
2. A. Singaravelu, Numerical Methods, MeenakshiAgency.2010.


**QUESTION PAPER PATTERN:**

| Section | Question Component | Numbers | Marks | Total |
|---|---|---|---|---|
| Section A | **Definition / Principles** Answer any 10 out of 12 questions | 1-12 | 3 | 30 |
| Section B | **Short Answer** Answer any 5 out of 7 questions | 13-19 | 6 | 30 |
| Section C | **Essay** Answer any 4 out of 6 questions | 20-25 | 10 | 40 |
| TOTAL MARKS | | | | 100 |

**DISTRIBUTION OF QUESTIONS:**

| **Sections** | **Units** | **No. of Questions** | |
|---|---|---|---|
| | | **Theory** | **Problems** |
| Section A | Unit – 1 | 3 | - |
| | Unit – 2 | 3 | - |
| | Unit – 3 | - | 2 |
| | Unit – 4 | - | 2 |
| | Unit – 5 | - | 2 |
| Section B | Unit – 1 | - | 1 |
| | Unit – 2 | - | 2 |
| | Unit – 3 | - | 1 |
| | Unit – 4 | - | 2 |
| | Unit – 5 | - | 1 |
| Section C | Unit – 1 | - | 1 |
| | Unit – 2 | - | 2 |
| | Unit – 3 | - | 1 |
| | Unit – 4 | - | 2 |
| | Unit – 5 | - | 1 |

**EXTRA DISCIPLINARY ELECTIVE- I**

**Option –II**

**QUANTITATIVE APTITUDE**

| | | |
|---|---|---|
| **SUBJECT CODE: 21PEDE305** | **THEORY** | **MARKS: 100** |
| **SEMESTER: II** | **CREDITS: 3** | **TOTAL HOURS: 45** |

**COURSE FRAMEWORK:**

Introduction to fundamental concepts of Quantitative aptitude.

**COURSE OUTCOMES:**

On completion of the course the students will be able to

1. Acquire knowledge in Number system, Profit & loss, Average, Proportion, Time and work.
2. Understand the basic ideas in Geometry.
3. Acquire knowledge in Mensurations.
4. Understand about the basic concepts of Trigonometry.
5. Understand the about data interpretation

**Unit 1** **(9Hrs)**

**Arithmetic:** Number system -Percentage-Profit & Loss- Compound Interest-Average -Ratio - Proportion -Time and Work.

**Unit 2** **(9Hrs)**

**Geometry:** Basics of Geometry-Triangle-Polygons and Circle.

**Unit 3** **(9Hrs)**

**Menstruation:** Triangle-Parallelogram-Rectangle-Pathway in a Rectangle-Square-Rhombus-Trapezium-Circle and Semi-circle.

**Unit 4** **(9Hrs)**

**Trigonometry:** Trigonometric Ratio-Identities-Trigonometric values for common angles.

**Unit 5** **(9Hrs)**

**Data Interpretation:** Bar graphs -Pie Charts and Line graphs.

**PRESCRIBED TEXTBOOK:**

Quantitative Aptitude for Competitive Examinations by Dr.R.S.Agarwal S.Chand Publications.

**REFERENCE BOOKS:**


1. Quantitative Abilities Arithmetic Ability by KiranPrakashan
2. Quicker Maths byM.Tyra,BSC Publishing Co. Pvt. Ltd.
3. Quantitative Aptitude for CAT by ArunSharma, McGraw Hill Education.

**QUESTION PAPER PATTERN:**

| Section | Question Component | Numbers | Marks | Total |
|---|---|---|---|---|
| Section A | **Definition / Principles**<br>Answer any 10 out of 12 questions | 1-12 | 3 | 30 |
| Section B | **Short Answer**<br>Answer any 5 out of 7 questions | 13-19 | 6 | 30 |
| Section C | **Essay**<br>Answer any 4 out of 6 questions | 20-25 | 10 | 40 |
| TOTAL MARKS | | | | 100 |

**DISTRIBUTION OF QUESTIONS:**

| **Sections** | **Units** | **No. of Questions** | |
|---|---|---|---|
| | | **Theory** | **Problems** |
| Section A | Unit – 1 | 3 | - |
| | Unit – 2 | 3 | - |
| | Unit – 3 | 2 | - |
| | Unit – 4 | 2 | - |
| | Unit – 5 | 2 | - |
| Section B | Unit – 1 | - | 2 |
| | Unit – 2 | - | 2 |
| | Unit – 3 | - | 1 |
| | Unit – 4 | - | 1 |
| | Unit – 5 | - | 1 |
| Section C | Unit – 1 | - | 2 |
| | Unit – 2 | - | 2 |
| | Unit – 3 | - | 1 |
| | Unit – 4 | - | 1 |
| | Unit – 5 | - | 1 |

# SEMESTER - III

## CORE - IX
## COMPLEX ANALYSIS

| | | |
|---|---|---|
| **SUBJECT CODE: 21PMAT311** | **THEORY** | **MARKS: 100** |
| **SEMESTER: III** | **CREDITS: 4** | **TOTAL HOURS: 90** |

**COURSE FRAMEWORK:**

An elaborate study in complex analysis.

**COURSE OUTCOMES:**

On completion of the course the students will be able to

1. Establish the Cauchy's Integral Formula and the local properties of Analytic Functions.
2. Demonstrate the general form of Cauchy's Theorem, Chains and Cycles, Simple Connectivity and Homology.
3. Establish Harmonic Functions.
4. Contemplate Power Series Expansions, Infinite Products and Riemann Zeta Function.
5. Demonstrate Doubly Periodic Functions and the Weierstrass' Theory.

**UNIT-I** **(18hrs)**

**Cauchy's Integral Formula:** The Index of a Point with Respect to A Closed Curve - The Integral Formula - Higher Derivatives.

**Local Properties of Analytic Functions:** Removable Singularities-Taylor's Theorem-Zeros and Poles-The Local Mapping - The Maximum Principle.

**Chapter 4:** Sections 2.1 to 2.3 and Sections 3.1 to 3.4

**UNIT-II** **(18hrs)**

**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

**The Calculus of Residues**– Residue Theorem - The Argument Principle.

**Chapter 4**: Sections 4.1 to 4.5 and Sections 5.1 & 5.2

**UNIT-III** **(18hrs)**

**Harmonic Functions:** Definition and Basic Properties of Harmonic Functions - Mean Value Property – Poisson's Formula-Schwarz's Theorem

**The Riemann mapping Theorem:** Statement and proof.

**A Closure look at Harmonic function:** Harnack's principle.

**Chapter 4 :** Sections 6.1 to 6.4

**Chapter 6:** Section 1.1 and Section 3.2

**UNIT-IV** **(18hrs)**

**Power Series Expansions:** Weierstrass's Theorem- Laurent series.
**Partial Fractions and Factorization:** Partial Fractions–Infinite Products-Canonical Products-The Gamma Function
**The Riemann Zeta Function:** The Product development

**Chapter 5:** Sections 1.1 & 1.3, Sections 2.1 to 2.4 and Sections 4.1

**UNIT-V** **(18hrs)**

**Doubly Periodic Functions**: The Period Module- Unimodular Transformations – General Properties of Elliptic Functions.
**The Weierstrass Theory** : The Weierstrass $\wp$-function – The Functions $\zeta(z)$ and $\sigma(z)$- – The Differential Equation – The Modular Function $\lambda(\tau)$.

**Chapter 7:** Sections 2.1, 2.2 & 2.4 and Sections 3.1 to 3.4

**PRESCRIBED TEXTBOOK:**

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

**REFERENCE BOOKS:**


1. H.A. Priestly, Introduction to Complex Analysis, Clarendon Press, Oxford,2003.
2. J.B.Conway, Functions of one complex variable, Springer International Edition, 2003.
3. T.W.Gamelin, Complex Analysis, Springer International Edition, 2004.
4. D.Sarason, Notes on Complex function Theory, Hindustan Book Agency,1998

**QUESTION PAPER PATTERN:**

| Section | Question Component | Numbers | Marks | Total |
|---|---|---|---|---|
| Section A | **Definition / Principles**<br>Answer any 10 out of 12 questions | 1-12 | 3 | 30 |
| Section B | **Short Answer**<br>Answer any 5 out of 7 questions | 13-19 | 6 | 30 |
| Section C | **Essay**<br>Answer any 4 out of 6 questions | 20-25 | 10 | 40 |
| TOTAL MARKS | | | | 100 |

**DISTRIBUTION OF QUESTIONS:**

| **Sections** | **Units** | **No. of Questions** | |
|---|---|---|---|
| | | **Theory** | **Problems** |
| Section A | Unit – 1 | 2 | - |
| | Unit – 2 | 3 | - |
| | Unit – 3 | 2 | - |
| | Unit – 4 | 3 | - |
| | Unit – 5 | 2 | - |
| Section B | Unit – 1 | 2 | - |
| | Unit – 2 | 1 | - |
| | Unit – 3 | 2 | - |
| | Unit – 4 | 1 | - |
| | Unit – 5 | 1 | - |
| Section C | Unit – 1 | 1 | - |
| | Unit – 2 | 1 | - |
| | Unit – 3 | 2 | - |
| | Unit – 4 | 1 | - |
| | Unit – 5 | 1 | - |

## CORE - X
## TOPOLOGY

| | | |
|---|---|---|
| **SUBJECT CODE :19PMAT313** | **THEORY** | **MARKS: 100** |
| **SEMESTER: III** | **CREDITS: 4** | **TOTAL HOURS: 90** |

**COURSE FRAMEWORK:**

To read understand and develop the dynamic in topology.

**COURSE OUTCOMES:**

On completion of the course the students will be able to

1. Acquire knowledge the topological space, open and closed sets, limit points and continuous functions are introduced as natural generalizations of the real line and Euclidean space.
2. Study the connectedness and compactness and related problems.
3. Demonstrate the countability and separation axioms and related exercises.
4. Study the product topology and Tychonoff theorem and related problems.
5. Apply the homotopy of paths and fundamental group and related exercises.

**UNIT-I** **(18hrs)**

**Topological Spaces and Continuous Functions**: Topological spaces, Basis for a topology, Product topology on X x Y, Subspace topology, Closed sets and Limit points, Continuous functions.

**Chapter 2:** Sections 12, 13 & 15 to 18.

**UNIT-II** **(18hrs)**

**Connectedness and Compactness**: Connected spaces, Connected subspaces of the real line, Components and Local connectedness, Compact spaces, Compact subspaces of the real line.

**Chapter 3:** Sections 23 to 27

**UNIT-III** **(18hrs)**

**Countability and Separation Axioms** Countability axioms, Separation axioms, Normal spaces ,Urysohn Lemma, Urysohn metrization theorem, Tietze extension theorem.

**Chapter 4:** Sections 30 to 35.

**UNIT-IV** **(18hrs)**

**Topological Spaces and Continuous Functions** Product topology: J-tuple of elements, Cartesian product, box topology, product topology, Tychonoff theorem.

**Chapter 2:** Section 19.
**Chapter 5:** Section 37.

**UNIT-V** **(18hrs)**

**The Tychonoff Theorem:** Homotopy of paths: homotopic, null homotopic, path homotopic, product of two paths, Fundamental group: loop, fundamental group, simply connected set, homomorphism induced by a map.

**Chapter 9:** Sections 51 & 52.

**PRESCRIBED TEXTBOOK:**

James R. Munkres ,Topology (Second edition) PHI, 2015.

**REFERENCE BOOKS:**


1. T. W. Gamelin and R.E. Greene, Introduction to Topology, The Saunders Series, 1983.
2. G. F. Simmons, Introduction to Topology and Modern Analysis, Mcgraw-Hill
3. J. Dugundji, Topology, Prentice Hall ofIndia.
4. J. L. Kelly, General Topology,Springer.
5. S. Willard, General Topology,Addison-Wesley.

**QUESTION PAPER PATTERN:**

| Section | Question Component | Numbers | Marks | Total |
|---|---|---|---|---|
| Section A | **Definition / Principles**<br>Answer any 10 out of 12 questions | 1-12 | 3 | 30 |
| Section B | **Short Answer**<br>Answer any 5 out of 7 questions | 13-19 | 6 | 30 |
| Section C | **Essay**<br>Answer any 4 out of 6 questions | 20-25 | 10 | 40 |
| TOTAL MARKS | | | | 100 |

**DISTRIBUTION OF QUESTIONS:**

| **Sections** | **Units** | **No. of Questions** | |
|---|---|---|---|
| | | **Theory** | **Problems** |
| Section A | Unit – 1 | 2 | 1 |
| | Unit – 2 | 2 | 1 |
| | Unit – 3 | 2 | - |
| | Unit – 4 | 2 | - |
| | Unit – 5 | 2 | - |
| Section B | Unit – 1 | 1 | 1 |
| | Unit – 2 | 1 | 1 |
| | Unit – 3 | 1 | - |
| | Unit – 4 | 1 | - |
| | Unit – 5 | 1 | - |
| Section C | Unit – 1 | 1 | - |
| | Unit – 2 | 1 | - |
| | Unit – 3 | 2 | - |
| | Unit – 4 | 1 | - |
| | Unit – 5 | 1 | - |

**CORE- X**
**MECHANICS**

| | | |
|---|---|---|
| **SUBJECT CODE: 21PMAT312** | **THEORY** | **MARKS: 100** |
| **SEMESTER: III** | **CREDITS: 4** | **TOTAL HOURS: 90** |

**COURSE FRAMEWORK:**

To find the mathematical models in mechanical system.

**COURSE OUTCOMES:**

On completion of the course the students will be able to

1. Demonstrate the Generalized Co-ordinates, Virtual Work, Energy and Momentum.
2. Apply the Lagrange's equation for holonomic, non-holonomic systems, Ignorable coordinates, Routhian function are learnt. Differential equations of motion are derived using the above methods.
3. Knowledge on Hamilton's Principle, Equations and Other Variational Principles.
4. Build up Hamilton-Jacobi form and Stackels conditions are derived.
5. Analysis the Differential Forms, Generating Functions, Special Transformations and Lagrangeand Poisson Brackets.

**UNIT-I** **(18 hrs)**

**Introductory Concepts:** The Mechanical system – Generalized coordinates – Constraints – Virtual work – Energy and Momentum.

**Chapter 1:** Sections 1.1 to 1.5

**UNIT-II** **(18 hrs)**

**Lagrange's Equations:** Derivation of Lagrange's equations – Examples –Integrals of motion.

**Chapter 2:** Sections 2.1 to 2.3

**UNIT-III** **(18 hrs)**

**Hamilton's Equations:** Hamilton's Principle –Hamilton's Equations – Other variational principles.

**Chapter 4:** Sections 4.1 to 4.3

**UNIT-IV** **(18 hrs)**

**Hamilton-Jacobi Theory:** Hamilton's Principle function – Hamilton-Jacobi Equation

**Chapter 5:** Sections 5.1 & 5.2

**UNIT-V** **(18 hrs)**

**Canonical Transformation:** Differential forms and generating functions – Special Transformations–Lagrange and Poisson brackets.

**Chapter 6:** Sections 6.1 to 6.3

**PRESCRIBED TEXTBOOK:**

Donald T. Greenwood, Classical Dynamics, Prentice Hall of India, New Delhi, 1985.

**REFERENCE BOOKS:**


1. H. Goldstein, Classical Mechanics, (2nd Edition) Narosa Publishing House, New Delhi.
2. N.C.Rane and P.S.C.Joag, Classical Mechanics, Tata McGraw Hill, 1991.
3. J.L.Synge and B.A.Griffth, Principles of Mechanics (3rd Edition) McGraw Hill Book Co., New York, 1970.


**QUESTION PAPER PATTERN:**

| Section | Question Component | Numbers | Marks | Total |
|---|---|---|---|---|
| Section A | **Definition / Principles** Answer any 10 out of 12 questions | 1-12 | 3 | 30 |
| Section B | **Short Answer** Answer any 5 out of 7 questions | 13-19 | 6 | 30 |
| Section C | **Essay** Answer any 4 out of 6 questions | 20-25 | 10 | 40 |
| TOTAL MARKS | | | | 100 |

**DISTRIBUTION OF QUESTIONS:**

| **Sections** | **Units** | **No. of Questions** | |
|---|---|---|---|
| | | **Theory** | **Problems** |
| Section A | Unit – 1 | 3 | - |
| | Unit – 2 | 2 | - |
| | Unit – 3 | 3 | - |
| | Unit – 4 | 2 | - |
| | Unit – 5 | 2 | - |
| Section B | Unit – 1 | 1 | 1 |
| | Unit – 2 | 1 | - |
| | Unit – 3 | 1 | 1 |
| | Unit – 4 | 1 | - |
| | Unit – 5 | 1 | - |
| Section C | Unit – 1 | 1 | 1 |
| | Unit – 2 | 1 | - |
| | Unit – 3 | 1 | - |
| | Unit – 4 | 1 | - |
| | Unit – 5 | 1 | - |

## ELECTIVE – III

### Option-I
### STOCHASTIC PROCESSES

| | | |
|---|---|---|
| **SUBJECT CODE: 21PMAT314** | **THEORY** | **MARKS: 100** |
| **SEMESTER: III** | **CREDITS: 3** | **TOTAL HOURS: 90** |

**COURSE FRAMEWORK:**

To study the main concepts involving stochastic process.

**COURSE OUTCOMES:**

On completion of the course the students will be able to

1. State the defining properties of various stochastic process models.
2. Sample on a computer any type of continuous or discrete time stochastic process.
3. Identify appropriate stochastic process model(s) for a given research or applied problem.
4. Provide logical and coherent proofs of important theoretic results.
5. Apply the theory to model real phenomena and answer some questions in applied sciences.

**UNIT-I** **(18hrs)**

**Random Variables and Stochastic Processes**: Introduction – Specification of stochastic processes

**Markov Chains:** Definitions and examples –Higher transition probabilities

**Martingales:** Introduction **–** Definitions and examples - Martingales convergence theorem

**Stationary Processes and Time Series:** Stationary processes.

**Chapter 1:** Section 1.5
**Chapter 2:** Sections 2.1 & 2.2
**Chapter 3:** Sections 5.1, 5.2 & 5. 3.2
**Chapter 8:** Sections 8.1

**UNIT-II** **(18hrs)**

**Markov Chains:** Classifications of states and chains – Determination of higher transition probabilities.

**Chapter 2:** Sections 2.4 & 2.5

**UNIT-III** **(18hrs)**

**Markov Processes with Discrete State Space Poisson process and its extensions:**

Poisson process - Poisson process and Related distributions.

**Chapter 3:** Sections 3.1 & 3.2

**UNIT– IV** **(18hrs)**

**Branching Processes:** Introduction-Properties of generating functions of branching processes Probability of ultimate extinction– Distribution of the total number of progeny – Conditional limit laws.

**Chapter 9:** Sections 9.1 to 9.5

**UNIT-V** **(18hrs)**

**Applications in Stochastic Models:** Queueing Systems and Models – Queueing Systems and Models – Notation-Steady State Distribution -Little's Formula - Birth and Death Processes in Queueing Theory:Markovian Models - Birth and Death Processes- The Model M/M/s- Model M/M/s/s: Erlang Loss Model.

**Chapter 10:** Sections 10.1 & 10.2

**PRESCRIBED TEXTBOOK:**

Stochastic Processes by J. Medhi,3rd Edition, New Age International (P) Ltd.

**REFERENCE BOOKS:**


1. Cinlar.E., Introduction to Stochastic Processes, Englewood Cliffs, Prentice-Hall
2. Srinivasan S.K. and Mehata K.M., Stochastic Processes, 2nd Edition, Tata McGraw Hill, New Delhi,1988.
3. Taylor H.N. and Karlin S., An Introduction to Stochastic Modeling, Academic Press.

**QUESTION PAPER PATTERN:**

| Section | Question Component | Numbers | Marks | Total |
|---|---|---|---|---|
| Section A | **Definition / Principles**<br>Answer any 10 out of 12 questions | 1-12 | 3 | 30 |
| Section B | **Short Answer**<br>Answer any 5 out of 7 questions | 13-19 | 6 | 30 |
| Section C | **Essay**<br>Answer any 4 out of 6 questions | 20-25 | 10 | 40 |
| TOTAL MARKS | | | | 100 |

**DISTRIBUTION OF QUESTIONS:**

| **Sections** | **Units** | **No. of Questions** | |
|---|---|---|---|
| | | **Theory** | **Problems** |
| Section A | Unit – 1 | 2 | 1 |
| | Unit – 2 | 2 | 1 |
| | Unit – 3 | 1 | 1 |
| | Unit – 4 | 1 | 1 |
| | Unit – 5 | 1 | 1 |
| Section B | Unit – 1 | 1 | 1 |
| | Unit – 2 | 1 | - |
| | Unit – 3 | 1 | - |
| | Unit – 4 | 1 | - |
| | Unit – 5 | 1 | 1 |
| Section C | Unit – 1 | 1 | - |
| | Unit – 2 | 1 | - |
| | Unit – 3 | 1 | - |
| | Unit – 4 | 1 | - |
| | Unit – 5 | 1 | 1 |

**ELECTIVE - III**

**Option - II**

**ALGEBRAIC THEORY OF NUMBERS**

| | | |
|---|---|---|
| **SUBJECT CODE: 21PMAT314** | **THEORY** | **MARKS: 100** |
| **SEMESTER: III** | **CREDITS: 3** | **TOTAL HOURS: 90** |

**COURSE FRAMEWORK:**

Introduction of the concepts of algebraic numbers and Rings of Integers.

**COURSE OUTCOMES:**

On completion of the course the students will be able to

1. Understand the concept of Factorization of Polynomials and Modules
2. Learn definition and significance of algebraic numbers and algebraic integers.
3. Study about Integral bases and Rings of integers
4. Acquire knowledge on Quadratic fields and Cyclotomic fields.
5. Demonstrate understanding of factorization into irreducibles.

**UNT-I** **(18hrs)**

**Algebraic Background:** Rings and Fields – Factorization of Polynomials – Field extensions – Symmetric polynomials – Modules – Free Abelian groups.

**Chapter 1:** Sections – 1.1 to 1.6

**UNIT-II** **(18hrs)**

**Algebraic Numbers:** Algebraic Numbers - Conjugate and Discriminants – Algebraic integers.

**Chapter 2:** Sections – 2.1 to 2.3

**UNIT-III** **(18hrs)**

**Algebraic Numbers:** Integral bases – Norms and traces – Rings of integers

**Chapter 2:** Sections – 2.4 to 2.6

**UNIT-IV** **(18hrs)**

**Quadratic fields and Cyclotomic fields:** Quadratic fields – Cyclotomic fields

**Chapter 3:** Sections – 3.1 & 3.2

**UNIT-V** **(18hrs)**

**Factorization into irreducible:** Historical background: – trivial factorization – factorization into irreducibles.

**Chapter 4:** Sections – 4.1 to 4.3

**PRESCRIBED TEXTBOOK:**

I.Stewart and D.Tall. Algebraic number theory and Fermat's Last theorem (3rd edition) A.K Peters Ltd,Natrick, Mass. 2002

**REFERENCE BOOKS:**


1. Z. I. Borevic and I.R.Safarevic, Number theory, Academic Press, NY, 1966.
2. J.W.S.cassels and A.Frohlich, Algebraic , Number theory, Academic Press, New York, 1967.
3. P. Ribenboim, Algebraic numbers, Wiley, New York, 1972.
4. P.Samuel, Algebraic Theory of Numbers, Houghton Mifflin company, Boston, 1970

**QUESTION PAPER PATTERN:**

| Section | Question Component | Numbers | Marks | Total |
|---|---|---|---|---|
| Section A | **Definition / Principles**<br>Answer any 10 out of 12 questions | 1-12 | 3 | 30 |
| Section B | **Short Answer**<br>Answer any 5 out of 7 questions | 13-19 | 6 | 30 |
| Section C | **Essay**<br>Answer any 4 out of 6 questions | 20-25 | 10 | 40 |
| TOTAL MARKS | | | | 100 |

**DISTRIBUTION OF QUESTIONS:**

| **Sections** | **Units** | **No. of Questions** | |
|---|---|---|---|
| | | **Theory** | **Problems** |
| Section A | Unit – 1 | 2 | |
| | Unit – 2 | 3 | |
| | Unit – 3 | 3 | |
| | Unit – 4 | 2 | |
| | Unit – 5 | 2 | |
| Section B | Unit – 1 | 2 | |
| | Unit – 2 | 1 | |
| | Unit – 3 | 1 | |
| | Unit – 4 | 1 | |
| | Unit – 5 | 2 | |
| Section C | Unit – 1 | 2 | |
| | Unit – 2 | 1 | |
| | Unit – 3 | 1 | |
| | Unit – 4 | 1 | |
| | Unit – 5 | 1 | |

**EXTRA DISCIPLINARY ELECTIVE- II**
**Option-I**
**STATISTICAL METHODS**

| | | |
|---|---|---|
| **SUBJECT CODE: 21PEDE314** | **THEORY** | **MARKS: 100** |
| **SEMESTER: III** | **CREDITS: 3** | **TOTAL HOURS: 45** |

**COURSE FRAMEWORK:**

To understand the problem-solving technique using statistical tools.

**COURSE OUTCOMES:**

On completion of the course the students will be able to

1. Explain the correlation and its methods.
2. Find the Regression Equations-Deviation taken from arithmetic mean of X and Y
3. Apply the Chi square test-test of independence to solving the problems.
4. Compute the problems in Analysis of variance-one-way classifications.
5. Explain the concept of Markov analysis-state transition matrix-transition diagram.

**UNIT-I** **(9hrs)**

Correlation – Methods of correlation – Karl-Pearson's coefficient of correlation-Spearman's rank correlations (except correlation of grouped data and concurrent deviation)

**Chapter 7** of Book [1]

**UNIT-II** **(9hrs)**

Regression equations-Deviation taken from arithmetic mean of X and Y-Deviation taken from assumed mean.

**Chapter 8** of Book [1]

**UNIT-III** **(9hrs)**

Chi square test-test of independence-test of goodness of fit- test of homogeneity

**Chapter 13** of Book [1]

**UNIT-IV** **(9hrs)**

Analysis of variance-one-way classifications

**Chapter 14** of Book [1]

**UNIT-V** (9hrs)

Markov analysis-State transition matrix- Transition diagram-construction of state transition matrix- Markov analysis algorithm.

**Chapter 15** of Book [2]

**PRESCRIBED TEXTBOOKS:**

1. Elementary Statistical Methods, Dr.S.P.Gupta, Sultanchand & Sons, New Delhi, Eighteen Edition,2009
2. Operations Research, Kanti Swarup, P.K.Gupta, Man Mohan Sultanchand & Sons,New Delhi,Twelth Edition,2004

**REFERENCE BOOKS:**

1. Fundamentals of Statistics, S.C.Gupta, Himalaya publishing house, Sixth edition, 2004.

**QUESTION PAPER PATTERN:**

| Section | Question Component | Numbers | Marks | Total |
|---|---|---|---|---|
| Section A | **Definition / Principles** Answer any 10 out of 12 questions | 1-12 | 3 | 30 |
| Section B | **Short Answer** Answer any 5 out of 7 questions | 13-19 | 6 | 30 |
| Section C | **Essay** Answer any 4 out of 6 questions | 20-25 | 10 | 40 |
| TOTAL MARKS | | | | 100 |

**DISTRIBUTION OF QUESTIONS:**

| **Sections** | **Units** | **No. of Questions** | |
|---|---|---|---|
| | | **Theory** | **Problems** |
| Section A | Unit – 1 | 1 | 1 |
| | Unit – 2 | 1 | 1 |
| | Unit – 3 | 1 | 1 |
| | Unit – 4 | 1 | 2 |
| | Unit – 5 | 1 | 2 |
| Section B | Unit – 1 | - | 1 |
| | Unit – 2 | - | 1 |
| | Unit – 3 | - | 2 |
| | Unit – 4 | - | 1 |
| | Unit – 5 | - | 2 |
| Section C | Unit – 1 | - | 2 |
| | Unit – 2 | - | 1 |
| | Unit – 3 | - | 1 |
| | Unit – 4 | - | 1 |
| | Unit – 5 | - | 1 |

**EXTRA DISCIPLINARY ELECTIVE- II**
**Option -II**
**LOGICAL REASONING FOR COMPETITIVE EXAMINATIONS**

| | | |
|---|---|---|
| **SUBJECT CODE: 21PEDE314** | **THEORY** | **MARKS: 100** |
| **SEMESTER: III** | **CREDITS: 3** | **TOTAL HOURS: 45** |

**COURSE FRAMEWORK:**

Introduction of problem-solving technique in logical reasoning for competitive exams.

**COURSE OUTCOMES:**

On completion of the course the students will be able to

1. Acquire the basic knowledge in alphanumeric Series, reasoning Analogies, blood Relations.
2. Study the calendars, clocks, coding- decoding.
3. Understand the data sufficiency, decision making, dices.
4. Study the directions, order & ranking, seating arrangements.
5. Apply the statement & assumptions, statement & conclusions, syllogism.

**UNIT-I** **(9hrs)**

Alphanumeric Series, Reasoning Analogies, Blood Relations

**UNIT-II** **(9hrs)**

Calendars, Clocks, Coding- Decoding.

**UNIT-III** **(9hrs)**

Data Sufficiency, Decision Making, Dices.

**UNIT-IV** **(9hrs)**

Directions, Order & Ranking, Seating Arrangements

**UNIT-V** **(9hrs)**

Statement & Assumptions, Statement & Conclusions, Syllogism

**PRESCRIBED TEXTBOOK:**

A modern approach to Logical Reasoning by Dr.R.S.Agarwal .S. Chand Publications

**REFERENCE BOOKS:**


1. A Comprehensive Book of Logical Reasoning, IBS Institute Chandigarh
2. Arihant ,Analytical & Logical Reasoning by Peeyush Bharadwaj, Arihant Publications
3. How to prepare for Logical Reasoning for CAT & other Management Examinations by Arun Sharma.,Mc. Graw Hill Publishers.

**QUESTION PAPER PATTERN:**

| Section | Question Component | Numbers | Marks | Total |
|---|---|---|---|---|
| Section A | **Definition / Principles**<br>Answer any 10 out of 12 questions | 1-12 | 3 | 30 |
| Section B | **Short Answer**<br>Answer any 5 out of 7 questions | 13-19 | 6 | 30 |
| Section C | **Essay**<br>Answer any 4 out of 6 questions | 20-25 | 10 | 40 |
| TOTAL MARKS | | | | 100 |

**DISTRIBUTION OF QUESTIONS:**

| **Sections** | **Units** | **No. of Questions** | |
|---|---|---|---|
| | | **Theory** | **Problems** |
| Section A | Unit – 1 | - | 2 |
| | Unit – 2 | - | 2 |
| | Unit – 3 | - | 3 |
| | Unit – 4 | - | 3 |
| | Unit – 5 | - | 2 |
| Section B | Unit – 1 | - | 1 |
| | Unit – 2 | - | 1 |
| | Unit – 3 | - | 2 |
| | Unit – 4 | - | 1 |
| | Unit – 5 | - | 2 |
| Section C | Unit – 1 | - | 2 |
| | Unit – 2 | - | 1 |
| | Unit – 3 | - | 1 |
| | Unit – 4 | - | 1 |
| | Unit – 5 | - | 1 |

# SEMESTER - IV

## CORE – XII
## CALCULUS OF VARIATIONS AND INTEGRAL EQUATIONS

| | | |
|---|---|---|
| **SUBJECT CODE: 21PMAT315** | **THEORY** | **MARKS: 100** |
| **SEMESTER: IV** | **CREDITS: 4** | **TOTAL HOURS: 75** |

**COURSE FRAMEWORK**:

The course is designed to provide a solid foundation for understanding the problems of calculus of variations and its multiple methods and techniques, as well as to prepare students for the study of modern optimal control theory. To familiarize students with the techniques for solving Integral Equations.

**COURSE OUTCOMES:**

On completion of the course the students will be able to

1. State the defining Variational Problems with Fixed Boundaries.
2. Compute the Variational Problems with Moving Boundaries.
3. Analyze the Integral Equations to solve the related problems.
4. Formulate the conversion of ordinary differential equations into integral equations.
5. Explain the concept of homogeneous Fredholm integral equation

**Unit I** **(15 hrs)**

**Variational Problems with Fixed Boundaries**: Variational Problems with Fixed Boundaries: The Concept of Variation and Its properties – Euler's equation – Variational Problems for Functionals of the Form $\int_a^b \mathrm{F}(\mathrm{x},\mathrm{y},\mathrm{y}')\mathrm{dx}$ - Functional a Dependent on Higher-Order Derivatives – Functional Dependent on Functions of Several Independent Variables – Variational Problems in Parametric Form.

**Chapter-I:** Sec 1.1 to 1.6 of A. S. Gupta

**Unit II** **(15 hrs)**

**Variational Problems with Moving Boundaries**:

Functional of the Form $I[y(x) = \int_{x_1}^{x_2} \mathrm{F}(\mathrm{x},\mathrm{y},\mathrm{y}')\mathrm{dx}$– Variational Problem with a x1 Movable Boundary for a Functional Dependent on Two Functions - One sided variations – Reflection and Refraction of Extremals – Diffraction of Light Rays.

**Chapter-II:** Sec 2.1 to 2.5 of A. S. Gupta

**Unit III** **(15 hrs)**

**Preliminary Concepts**: Introduction – Abel's Problem – Integral equation, Definition – Linear and non-linear integral equations – Fredholm integral equation of the first kind, the second kind & the third kind – Homogeneous Fredholm integral equation - Volterra integral equation of the first kind , the third kind & the second kind - Homogeneous Volterra integral equation – Singular integral equation– Special kinds of kernels – Symmetric kernel – Separable or degenerate kernel – Integral equation of the convolution type – Iterated kernels of functions – Resolvent kernel or reciprocal kernel – Eigenvalues – Eigenfunctions-Leibnitz rule of differentiation under integral sign- An important formula for converting a multiple integral into a single ordinary integral- Regularity conditions- Square-integrable functions or $\mathcal{L}_2$- function- The inner or scalar product of two functions- Solution of an integral equation. Definition- Solved example.

**Chapter-1:** Sec 1.1 to 1.18 of Book [2]

**Unit IV** **(15hrs)**

**Conversion of Ordinary Differential Equations into Integral Equations:** Introduction – Initial Value Problems – Methods of Converting an Initial Value Problem into a Volterra Integral Equation – Boundary Value Problem – Methods of Converting a Boundary Value Problem into a Fredholm Integral Equation.

**Chapter2:** Sec 2.1 to 2.6 of Book [2]

**Unit V** **(15 hrs)**

**Homogeneous Fredholm Integral Equations**: Characteristic Values – Characteristic Functions – Solution of Homogeneous Fredholm Integral Equations of the Second Kind with Separable Kernel–Solved examples.

**Chapter-3:** Sec 3.1 to 3.3 of Book [2]

**PRESCRIBED BOOKS:**


1.S. Gupta, Calculus of Variations with Applications, Prentice- Hall of India, New Delhi, 1997.

2.M. D. Raisinghania, Integral Equations and Boundary Value Problems , S.Chand Publication


**REFERENCE BOOKS:**


1. Gupta. S, Calculus of Variations with Applications, Prentice- Hall of India, NewDelhi, 2005.
2. Ram P. Kanwal, Linear Integral Equations, Theory and Techniques. Academic Press, New York,2012.
3. Sudir K. Pundir and Rimple Pundir, Integral Equations and Boundary Value Problems Pragati Prakasam, Meerut,2005.
4. AnadiSankar Gupta, Calculus of variations, PHI Learning private Ltd

**QUESTION PAPER PATTERN:**

| Section | Question Component | Numbers | Marks | Total |
|---|---|---|---|---|
| Section A | **Definition / Principles**<br>Answer any 10 out of 12 questions | 1-12 | 3 | 30 |
| Section B | **Short Answer**<br>Answer any 5 out of 7 questions | 13-19 | 6 | 30 |
| Section C | **Essay**<br>Answer any 4 out of 6 questions | 20-25 | 10 | 40 |
| TOTAL MARKS | | | | 100 |

**DISTRIBUTION OF QUESTIONS:**

| **Sections** | **Units** | **No. of Questions** | |
|---|---|---|---|
| | | **Theory** | **Problems** |
| Section A | Unit – 1 | 1 | 2 |
| | Unit – 2 | 1 | 1 |
| | Unit – 3 | 1 | 1 |
| | Unit – 4 | 1 | 1 |
| | Unit – 5 | 1 | 2 |
| Section B | Unit – 1 | - | 1 |
| | Unit – 2 | - | 1 |
| | Unit – 3 | 1 | 1 |
| | Unit – 4 | 1 | - |
| | Unit – 5 | 1 | 1 |
| Section C | Unit – 1 | 1 | 1 |
| | Unit – 2 | 1 | - |
| | Unit – 3 | 1 | - |
| | Unit – 4 | 1 | - |
| | Unit – 5 | 1 | - |

## CORE - XIII
## DIFFERENTIAL GEOMETRY

| | | |
|---|---|---|
| **SUBJECT CODE: 21PMAT316** | **THEORY** | **MARKS: 100** |
| **SEMESTER: IV** | **CREDITS: 4** | **TOTAL HOURS: 75** |

**COURSE FRAMEWORK:**

To find the length in geometrical approach.

**COURSE OUTCOMES:**

On completion of the course the students will be able to

1. Knowledge of the Curves, parametrisation, arc length, level curves, curvature, plane and space curves and related problems.
2. Recognize the importance of the patches, smooth surfaces, tangents, normals, orientability, Examples of surfaces, Lengths of curves on surfaces, the first fundamental form,isometries, surface area and related problems.
3. Demonstrate the second fundamental form, Curvature of curves on a surface, normal, principal, Gaussian and mean curvatures, Gauss map and related exercises.
4. Apply on geodesics, geodesic equations, Geodesics as shortest paths, geodesic coordinates and related problems.
5. Analysis the theorem a Egregium, isometries of surfaces, Codazzi – Mainardi Equations, compact surfaces of constant Gaussian curvature and related exercises.

**UNIT-I** **(15hrs)**

**Curves in the plane and in space:** Curves -Arc length – Reparametrization-Closed Curves- Level curves versus parametrization curves

**How much does a Curve Curve:** Curvature -Plane curves - Space curves.

**Chapters: 1 & 2**

**UNIT-II** **(15hrs)**

**Surfaces in three dimensions:** Surface –Smooth surfaces-Smooth maps- Tangents and derivatives Normals and Orientability

**Examples of surfaces**: Level surfaces-Quadric surfaces-Compact surfaces

**Chapter 4:** 4.1 to 4.5
**Chapter 5:** 5.1, 5.2 & 5.4

**UNIT-III** **(15hrs)**

**Curvature of surfaces:** The second fundamental form- Curvature of curves on a surface- Normal and principal Curvature-

**Gaussian Curvature and the Gauss Map**: Gaussian and mean curvatures - Gaussian curvatures of compact surface --Gauss map.

**Chapter 6:** Sections 6.1, 6.2 & 6.3
**Chapter 7:** Sections 7.1, 7.5 & 7.6

**UNIT-IV** **(15hrs)**

**Geodesics**: Definition and Basic Properties -Geodesic equations-Geodesics as shortest paths- Geodesic coordinates.

**Chapter 8:** Sections 8.1, 8.2, 8.4 & 8.5

**UNIT-V** **(15hrs)**

**Gauss's Theorema Egregium:** Gauss's Remarkable Theorem-Isometries of surfaces-Codazzi-Mainardi Equations- Compact surfaces of constant Gaussian curvature.

**Chapter 10:** Sections 10.1 to 10.4

**PRESCRIBED TEXTBOOK:**

Andrew Pressley, Elementary Differential Geometry, Springer- Indian Edition, 2004.

**REFERENCE BOOKS:**


1. J.A. Thorpe, Elementary Topics in Differential Geometry, Springer-Indian edition.
2. E.D. Bloch, A First Course in Geometric Topology and Differential Geometry, Birkhauser,1997.
3. M.P. do Carmo, Differential Geometry of Curves and Surfaces, Prentice-Hall,1976.

**QUESTION PAPER PATTERN:**

| Section | Question Component | Numbers | Marks | Total |
|---|---|---|---|---|
| Section A | **Definition / Principles**<br>Answer any 10 out of 12 questions | 1-12 | 3 | 30 |
| Section B | **Short Answer**<br>Answer any 5 out of 7 questions | 13-19 | 6 | 30 |
| Section C | **Essay**<br>Answer any 4 out of 6 questions | 20-25 | 10 | 40 |
| TOTAL MARKS | | | | 100 |

**DISTRIBUTION OF QUESTIONS:**

| **Sections** | **Units** | **No. of Questions** | |
|---|---|---|---|
| | | **Theory** | **Problems** |
| Section A | Unit – 1 | 1 | 1 |
| | Unit – 2 | 2 | 1 |
| | Unit – 3 | 1 | 1 |
| | Unit – 4 | 1 | 1 |
| | Unit – 5 | 2 | 1 |
| Section B | Unit – 1 | 1 | 1 |
| | Unit – 2 | 1 | - |
| | Unit – 3 | 1 | 1 |
| | Unit – 4 | 1 | - |
| | Unit – 5 | 1 | - |
| Section C | Unit – 1 | 1 | 1 |
| | Unit – 2 | 1 | - |
| | Unit – 3 | 1 | - |
| | Unit – 4 | 1 | - |
| | Unit – 5 | 1 | - |

## CORE - XIV
## FUNCTIONAL ANALYSIS

| | | |
|---|---|---|
| **SUBJECT CODE: 21PMAT317** | **THEORY** | **MARKS: 100** |
| **SEMESTER: IV** | **CREDITS: 4** | **TOTAL HOURS: 75** |

**COURSE FRAMEWORK:**

A brief study in analyze about spaces.

**COURSE OUTCOMES:**

On completion of the course the students will be able to

1. Understand the Normed spaces, Continuity of linear maps, Hahn-Banach Theorems, Banach Spaces and related problems.
2. Study the Uniform boundedness principle, Closed Graph and Open Mapping theorems,Bounded Inverse Theorem, Spectrum of a bounded operator and related problems.
3. Understand the Duals and Transposes, Weak and weak *convergence, Reflexivity andrelated exercises.
4. Study the Inner Product Spaces, Orthonormal sets, Best approximation, Projection and Riesz-Representaion theorems and related problems.
5. Understand the Bounded operators and adjoints, Normal, unitary and Self-adjoint Operators, Spectrum and Numerical range and related exercises.

**UNIT-I** **(15hrs)**

**Fundamentals of Normed Spaces:** Normed Spaces – Riesz lemma –Continuity of Linear Maps.

**Chapter: II** Sections 5.1 to 5.7, 6.1 to 6.5

**UNIT-II** **(15hrs)**

**Fundamentals of Normed Spaces:** Bounded Linear Maps – Hahn Banach Theorems – Hahn-Banach separation theorem – Hahn- Banachextension theorems,Unique Hahn Banach Extensions – Banach Spaces.

**Chapter: II** Sections 6.6 to 6.8, 7.1 to 7.11, 8.1 to 8.4

**UNIT-III** **(15hrs)**

**Bounded Linear Maps on Banach Spaces:** Uniform Boundedness Principle – Resonance theorem – Closed Graph Theorem– Open mapping Theorem – Bounded Inverse Theorem – Two-norm theorem.

**Chapter: III** Sections 9.1 to 9.3, 10.1 to 10.7, 11.1 to 11.3

**UNIT-IV** **(15hrs)**

**Bounded Linear Maps on Banach Spaces:** Spectrum of Bounded Operator **Spaces of Bounded Linear Functional**: Weak and Weak* Convergence – Bolzano- Weierstrass Property –Reflexivity.

**Chapter: III** Sections 12.1 to 12.5
**Chapter: V** Sections 15.1 to 15.4, 16.1 to 16.4

**UNIT-V** **(15hrs)**

**Inner Product Spaces:** Inner Product Spaces – Orthonormal Sets – Bessel"s Inequality –
**Bounded Operators on Hilbert Spaces:** Bounded Operators – Normal, Unitary and Self - Adjoint Operators.
**Chapter: VI** Sections 21.1 to 21.3, 22.1 to 22.2, 22.4 to 22.7,

**Chapter-VII:** Sections 25.2, 26.1 to 26.3

**PRESCRIBED TEXTBOOK:**

B.V. Limaye, Functional Analysis, New Age International,1996.

**REFERENCE BOOKS:**


1. W. Rudin Functional Analysis, Tata McGraw-Hill PublishingCompany, New Delhi , 1973
2. G.Bachman&L.Narici, Functional Analysis Academic Press, New York,1966.
3. Goffman and G.Pedrick, First course in Functional Analysis, Prentice Hall of India,
4. 
5. New Delhi,1987
6. Kreyszig, Introductory Functional Analysis with Applications, John wiley& Sons, New York., 1978.
7. M.Thamban Nair, Functional Analysis. A First Course,Prentice Hall of India, New Delhi,2002

**QUESTION PAPER PATTERN:**

| Section | Question Component | Numbers | Marks | Total |
|---|---|---|---|---|
| Section A | **Definition / Principles** Answer any 10 out of 12 questions | 1-12 | 3 | 30 |
| Section B | **Short Answer** Answer any 5 out of 7 questions | 13-19 | 6 | 30 |
| Section C | **Essay** Answer any 4 out of 6 questions | 20-25 | 10 | 40 |
| TOTAL MARKS | | | | 100 |

**DISTRIBUTION OF QUESTIONS:**

| **Sections** | **Units** | **No. of Questions** | |
|---|---|---|---|
| | | **Theory** | **Problems** |
| Section A | Unit – 1 | 2 | 1 |
| | Unit – 2 | 2 | - |
| | Unit – 3 | 2 | - |
| | Unit – 4 | 2 | - |
| | Unit – 5 | 2 | 1 |
| Section B | Unit – 1 | 1 | 1 |
| | Unit – 2 | 1 | - |
| | Unit – 3 | 1 | - |
| | Unit – 4 | 1 | - |
| | Unit – 5 | 1 | 1 |
| Section C | Unit – 1 | 1 | - |
| | Unit – 2 | 2 | - |
| | Unit – 3 | 1 | - |
| | Unit – 4 | 1 | - |
| | Unit – 5 | 1 | - |

**CORE - XV**
**PROJECT**

| | | |
|---|---|---|
| **COURSE CODE: 21PMAT318** | **PRACTICAL** | **MARKS: 100** |
| **SEMESTER: IV** | **CREDITS: 4** | **NO. OF HOURS: 60** |

## ELECTIVE– IV

## Option -I
## GRAPH THEORY

| | | |
|---|---|---|
| **SUBJECT CODE: 21PMAT319** | **THEORY** | **MARKS: 100** |
| **SEMESTER: IV** | **CREDITS: 3** | **TOTAL HOURS: 75** |

**COURSE FRAMEWORK:**

Introduction of the basic concepts and related theorems in graph theory.

**COURSE OUTCOMES:**

On completion of the course the students will be able to

1. Elaborate Graphs, Sub graphs and Trees which helps in real-life to track the path or know the direction of the road using GPS.
2. Demonstrate Cut Vertices and Edge Connectivity and Vertex Connectivity which is a vital component in designing different Networks like Neural, Molecular and Communication etc.
3. Demonstrate Euler Tours, Hamilton Cycles and Edge Chromatic Number which aids to create circuits and in geographical map coloring.
4. Acquire knowledge on Independent Sets, Cliques and Vertex Colorings to find the optimal lines in Communication Network.
5. Classify Plane Graphs, Planar Graphs and study related Theorems on it which helps to find the uninterrupted gas pipe lines simulations in Civil Engineering.

**UNIT-I** **(15hrs)**

**Graphs and Subgraphs:** Graphs and Simple Graphs-Graph Isomorphism – The Incidence and Adjacency Matrices – Subgraphs – Vertex Degrees – Paths and Connection– Cycles. **Trees:** Trees

**Chapter 1:** Sections 1.1 to 1.7
**Chapter 2:** Section 2.1

**UNIT-II** **(15hrs)**

**Trees:** Cut Edges and Bonds – Cut Vertices
**Connectivity:** Connectivity C Blocks.

**Chapter 2:** Sections 2.2 & 2.3
**Chapter 3:** Section 3.1 & 3.2

**UNIT-III** **(15hrs)**

**Euler Tours and Hamilton Cycles:** Euler Tours - Hamilton Cycles
**Edge Colourings:** Edge Chromatic Number

**Chapter 4:** Sections 4.1 & 4.2
**Chapter 6:** Section 6.1

**UNIT-IV** **(15hrs)**

**Independents Sets and Cliques:** Independent sets – Ramsey"s Theorem.
**Vertex Colourings:** Chromatic Number – Brooks" Theorem

**Chapter 7:** Section 7.1 & 7.2
**Chapter 8:** Section 8.1 & 8.2

**UNIT-V** **(15hrs)**

**Planar Graphs:** Plane and Planar Graphs- Dual graphs – Euler's Formula – The Five- Colour Theorem and the Four- Colour Conjecture.

**Chapter 9:** (Section 9.1 to 9.3 & 9.6)

**PRESCRIBED TEXTBOOK:**

J. A. Bondy and U.S.R. Murty , Graph Theory with Applications, Macmillan, London, 1976.

**REFERENCE BOOKS:**


1. J. Clark and D. A. Holton A First look at Graph Theory, Allied Publishers,New Delhi 1995.
2. R. Gould. Graph Theory, Benjamin/Cummings, Menlo Park,1989.
3. R. J. Wilson and J. J. Watkins, Graphs, An Introductory Approach, John Wileyand Sons, New York,1989.
4. R.J. Wilson, Introduction to Graph Theory, Pearson Education, 4th Edition,2004, IndianPrint.
5. S. A. Choudum, A First Course in Graph Theory, MacMillan India Ltd. 1987

**QUESTION PAPER PATTERN:**

| Section | Question Component | Numbers | Marks | Total |
|---|---|---|---|---|
| Section A | **Definition / Principles**<br>Answer any 10 out of 12 questions | 1-12 | 3 | 30 |
| Section B | **Short Answer**<br>Answer any 5 out of 7 questions | 13-19 | 6 | 30 |
| Section C | **Essay**<br>Answer any 4 out of 6 questions | 20-25 | 10 | 40 |
| TOTAL MARKS | | | | 100 |

**DISTRIBUTION OF QUESTIONS:**

| **Sections** | **Units** | **No. of Questions** | |
|---|---|---|---|
| | | **Theory** | **Problems** |
| Section A | Unit – 1 | 3 | - |
| | Unit – 2 | 2 | - |
| | Unit – 3 | 2 | - |
| | Unit – 4 | 3 | - |
| | Unit – 5 | 2 | - |
| Section B | Unit – 1 | 1 | - |
| | Unit – 2 | 2 | - |
| | Unit – 3 | 1 | - |
| | Unit – 4 | 2 | - |
| | Unit – 5 | 1 | - |
| Section C | Unit – 1 | 1 | - |
| | Unit – 2 | 1 | - |
| | Unit – 3 | 2 | - |
| | Unit – 4 | 1 | - |
| | Unit – 5 | 1 | - |

## ELECTIVE – IV
## Option-II
## MATHEMATICAL STATISTICS

| | | |
|---|---|---|
| **SUBJECT CODE: 21PMAT319** | **THEORY** | **MARKS: 100** |
| **SEMESTER: IV** | **CREDITS: 3** | **TOTAL HOURS: 75** |

**COURSE FRAMEWORK:**

Introduction of the various methods of statistical applications.

**COURSE OUTCOMES:**

On completion of the course the students will be able to:

1. Acquire knowledge on Student t-distribution, chi-square distribution, Fishers Z distribution.
2. Elaborate various significance tests.
3. Analyze various methods of estimations.
4. Apply one-way and two-way classifications of Analysis of variance.
5. Analyze sequential analysis.

**UNIT-I** **(15hrs)**

**Sample Moments and their Functions:** The notion of a sample-The notion of a statistic-The distribution of the arithmetic mean of the independent normally distributed random variables- The $\chi^2$ distribution - The distribution of the statistic $(\bar{X} - S)$.

**Chapter 9:** Sections 9.1 to 9.5

**UNIT-II** **(15hrs)**

**Sample Moments and their Functions:** Student's t-distribution – Fisher's Z-distribution – The distribution of $\bar{X}$ for some non normal populations-The distribution of sample moments and sample correlation coefficients of a two-dimensional normal population-The distribution of regression coefficients

**Chapter 9:** Sections 9.6 to 9.10

**UNIT-III** **(15hrs)**

**Significance Tests:** The concept of a statistical test-Parametric tests for small samples-Parametric tests for large samples- The $\chi^2$ test-Tests of the Kolmogorov and Smirnov type The Wald- Wolfovitz and Wilcoxon-Mann-Whitney tests-Independence tests by contingency tables.

**Chapter 12:** Sections 12.1 to 12.7

**UNIT-IV** **(15hrs)**

**The Theory Of Estimation:** Preliminary notions-Consistent estimates-Unbiased estimates-The sufficiency of an estimate-The efficiency of an estimate- Asymptotically most efficient estimates- Methods of finding estimates-Confidence intervals.

**Chapter 13:** Sections 13.1 to 13.8.

**UNIT-V** **(15hrs)**

**Theory of Hypotheses Testing:** The power function and the OC function-Most powerful tests- Uniformly most powerful test-Unbiased tests

**Chapter 16:** Sections 16.2 to 16.5

**PRESCRIBED TEXTBOOK:**

M. Fisz, Probability Theory and Mathematical Statistics, John Wiley and sons, NewYork, 1963.

**REFERENCE BOOKS:**


1. R.B. Ash, Real Analysis and Probability, Academic Press, New York, 1972.
2. K.L.Chung, A course in Probability, Academic Press, New York, 1974.
3. Y.S.Chow and H.Teicher, Probability Theory, Springer Verlag. Berlin, 1988 (2nd Edition)
4. R.Durrett, Probability : Theory and Examples, (2nd Edition) Duxbury Press, New York, 1996.
5. V.K.Rohatgi, An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern Ltd., New Delhi, 1988(3rd Print).
6. S.I.Resnick, A Probability Path, Birhauser, Berlin,1999.
7. B.R.Bhat ,Modern Probability Theory (3rd Edition), New Age International (P)Ltd, New Delhi, 1999
8. J.P. Romano and A.F. Siegel, Counter Examples in Probability and Statistics, Wadsworth and Brooks / Cole Advanced Books and Software, California, 1968

**QUESTION PAPER PATTERN:**

| Section | Question Component | Numbers | Marks | Total |
|---|---|---|---|---|
| Section A | **Definition / Principles**<br>Answer any 10 out of 12 questions | 1 – 12 | 3 | 30 |
| Section B | **Short Answer**<br>Answer any 5 out of 7 questions | 13 – 19 | 6 | 30 |
| Section C | **Essay**<br>Answer any 4 out of 6 questions | 20 – 25 | 10 | 40 |
| TOTAL MARKS | | | | 100 |

**DISTRIBUTION OF QUESTIONS:**

| **Sections** | **Units** | **No. of Questions** | |
|---|---|---|---|
| | | **Theory** | **Problems** |
| Section A | Unit – 1 | 2 | - |
| | Unit – 2 | 2 | - |
| | Unit – 3 | 2 | - |
| | Unit – 4 | 2 | - |
| | Unit – 5 | 2 | - |
| Section B | Unit – 1 | 1 | - |
| | Unit – 2 | 1 | - |
| | Unit – 3 | 1 | - |
| | Unit – 4 | 1 | - |
| | Unit – 5 | 1 | - |
| Section C | Unit – 1 | 1 | - |
| | Unit – 2 | 1 | - |
| | Unit – 3 | 1 | - |
| | Unit – 4 | 1 | - |
| | Unit – 5 | 1 | - |

**ELECTIVE – V**
**Option-I**
**FUZZY SETS AND THEIR APPLICATIONS**

| | | |
|---|---|---|
| **SUBJECT CODE: 21PMAT320** | **THEORY** | **MARKS: 100** |
| **SEMESTER: IV** | **CREDITS: 3** | **TOTAL HOURS: 60** |

**COURSE FRAMEWORK:**

Develops the logical concepts involving fuzzy subsets.

**COURSE OUTCOME**

On completion of the course the students will be able to

1. Understand about Fuzzy sets and various operations.
2. Acquire knowledge Fuzzy graph, fuzzy relations and fuzzy subsets.
3. Explain Similitude, Dissimilitude, order relations.
4. Find out polynomial forms and composition of intervals.
5. Analyze Fuzzy groupoids, Fuzzy monoids and Fuzzy groups.

**UNIT-I** **(12hrs)**

**Fundamental Notions:** Review of the notion of membership, The concept of a fuzzy subset, Dominance relations, Simple operations on fuzzy subsets, Set of fuzzy subsets for E and M finite, Properties of the set of fuzzy subsets, Product and algebraic sum of two fuzzy subsets.

**Chapter 1:** Sections 1 to 8

**UNIT-II** **(12hrs)**

**Fuzzy Graphs:** Fuzzy relations, composition of Fuzzy relations, Fuzzy subsets induced by a mapping, conditioned Fuzzy subsets, Properties of Fuzzy binary relations, Transitive closure of a Fuzzy binary relations, Paths in a finite Fuzzy graphs.

**Chapter 2**: Sections 10 to 18

**UNIT-III** **(12hrs)**

**Fuzzy Relations:** Fuzzy preorder relations, Similitude relations, Similitude sub relations in a fuzzy preorder, Antisymmetry, Fuzzy order relations, Antisymmetric relations without loops. Ordinal relations. Ordinal functions in a fuzzy order relation, Dissimilitude relations, Resemblance relations, Various properties of similitude and resemblance, Various properties of fuzzy perfect order relations.

**Chapter 2:** Sections 19 to 29

**UNIT-IV** **(12hrs)**

**Fuzzy Logic:** Characteristic function of a fuzzy subset. Fuzzy variables, Polynomial forms, Analysis of a function of fuzzy variables. Method of Marinos, Logical structure of a function of fuzzy variables, Composition of intervals, Fuzzy propositions and their functional representations, The theory of fuzzy subsets and the theory of probability.

**Chapter 3:** Sections 31 to 36, 39 & 40

**UNIT-V** **(12hrs)**

**The Laws of Fuzzy Composition:** Review of the notion of a law of composition, Laws of fuzzy internal composition. Fuzzy groupoids, Principal properties of fuzzy groupoids, Fuzzy monoids, Fuzzy external composition, Operations on fuzzy numbers.

**Chapter 4:** Sections 43 to 49

**PRESCRIBED TEXTBOOK:**

A. Kaufman, Introduction to the theory of Fuzzy subsets, Vol. I, Academic Press, New York, 1975.

**REFERENCE BOOKS:**


1. H. J. Zimmermann, Fuzzy Set Theory and its Applications, Allied Publishers, Chennai,1996
2. George J. Klir and Bo Yuan, Fuzzy sets and Fuzzy Logic-Theory and Applications, Prentice Hall India, New Delhi,2001.
3. L.A. Zadeh, Fuzzy Set Theory and its Applications, $4^{th}$ edition.

**QUESTION PAPER PATTERN:**

| Section | Question Component | Numbers | Marks | Total |
|---|---|---|---|---|
| Section A | **Definition / Principles**<br>Answer any 10 out of 12 questions | 1-12 | 3 | 30 |
| Section B | **Short Answer**<br>Answer any 5 out of 7 questions | 13-19 | 6 | 30 |
| Section C | **Essay**<br>Answer any 4 out of 6 questions | 20-25 | 10 | 40 |
| TOTAL MARKS | | | 100 | |

**DISTRIBUTION OF QUESTIONS:**

| **Sections** | **Units** | **No. of Questions** | |
|---|---|---|---|
| | | **Theory** | **Problems** |
| Section A | Unit – 1 | 2 | 1 |
| | Unit – 2 | 2 | - |
| | Unit – 3 | 2 | 1 |
| | Unit – 4 | 2 | - |
| | Unit – 5 | 2 | - |
| Section B | Unit – 1 | 1 | - |
| | Unit – 2 | 1 | 1 |
| | Unit – 3 | 1 | 1 |
| | Unit – 4 | 1 | - |
| | Unit – 5 | 1 | - |
| Section C | Unit – 1 | 1 | 1 |
| | Unit – 2 | 1 | - |
| | Unit – 3 | 1 | - |
| | Unit – 4 | 1 | - |
| | Unit – 5 | 1 | - |

**ELECTIVE – V**

**Option-II**

**ALGEBRAIC TOPOLOGY**

| | | |
|---|---|---|
| **SUBJECT CODE: 21PMAT320** | **THEORY** | **MARKS: 100** |
| **SEMESTER: IV** | **CREDITS: 3** | **TOTAL HOURS: 60** |

**COURSE FRAMEWORK:**

To understand fundamental ideas in Algebraic Topology.

**COURSE OUTCOMES:**

On completion of the course the students will be able to:

1. Acquire knowledge on Homotopy of paths and Retractions and Fixed points.
2. Study the Fundamental groups of some surfaces.
3. Demonstrate the Seifert–van Kampen Theorem
4. Acquire knowledge on Constructing compact surfaces.
5. Classify Covering transformations and Covering Spaces.

**UNIT-I** **(12hrs)**

**The Fundamental Group**: Homotopy of paths - The Fundamental Group – Covering spaces - The Fundamental Group of the circle – Retractions and Fixed points.

**Chapter 9:** Sections 51 to 55.

**UNIT-II** **(12hrs)**

**The Fundamental Group**: The Fundamental Theorem of Algebra – The Borsuk–Ulam Theorem – Deformation Retracts and Homotopy Type – The Fundamental Group of $S^n$ - Fundamental Groups of some surfaces.

**Chapter 9:** Sections 56 **to** 60

**UNIT-III** **(12hrs)**

**The Seifert-van Kampen Theorem :**Direct sums of Abelian Groups – Free products of Groups – Free Groups – The Seifert–van Kampen Theorem – The Fundamental Group of a wedge of circles.

**Chapter 11:** Sections 67 to 71.

**UNIT-IV** **(12hrs)**

**Classification of Surfaces:** Fundamental groups of surfaces – Homology of surfaces – Cutting and pasting – The classification theorem – Constructing compact surfaces.

**Chapter 12:** Sections 74 to 78

**UNIT-V** **(12hrs)**

**Classification of Covering Spaces:** Equivalence of covering spaces – The Universal covering space – Covering transformations – Existence of covering spaces

**Chapter 13:** Sections 79 to 82

**PRESCRIBED TEXTBOOK:**

J.R. Munkres,Toplogy, Pearson Education Asia , Second Edition 2002

**REFERENCE BOOKS:**


1. M.K.Agoston, Algebraic topology – A First Course, Marcel Dekker, 1962.
2. Satya Deo, Algebraic Topology , Hindustan Book Agency, New Delhi, 2003.
3. M.Greenberg and Harper, Algebraic Topology – A First course, Benjamin/Cummings, 1981.
4. C.F. Maunder, Algebraic topology, Van Nostrand, New York, 1970.
5. A.Hatcher, Algebraic Topology, CambridgeUniversity Press, South Asian Edition 2002.
6. W.S.Massey, Algebrai Topology : An Introduction, Springer 1990

**QUESTION PAPER PATTERN:**

| Section | Question Component | Numbers | Marks | Total |
|---|---|---|---|---|
| Section A | **Definition / Principles**<br>Answer any 10 out of 12 questions | 1-12 | 3 | 30 |
| Section B | **Short Answer**<br>Answer any 5 out of 7 questions | 13-19 | 6 | 30 |
| Section C | **Essay**<br>Answer any 4 out of 6 questions | 20-25 | 10 | 40 |
| TOTAL MARKS | | | | 100 |

**DISTRIBUTION OF QUESTIONS:**

| **Sections** | **Units** | **No. of Questions** | |
|---|---|---|---|
| | | **Theory** | **Problems** |
| Section A | Unit – 1 | 2 | 1 |
| | Unit – 2 | 2 | 1 |
| | Unit – 3 | 2 | - |
| | Unit – 4 | 2 | - |
| | Unit – 5 | 2 | - |
| Section B | Unit – 1 | 1 | 1 |
| | Unit – 2 | 1 | 1 |
| | Unit – 3 | 1 | - |
| | Unit – 4 | 1 | - |
| | Unit – 5 | 1 | - |
| Section C | Unit – 1 | 1 | - |
| | Unit – 2 | 1 | - |
| | Unit – 3 | 2 | - |
| | Unit – 4 | 1 | - |
| | Unit – 5 | 1 | - |