**SAKTHI COLLEGE OF ARTS AND SCIENCE FOR WOMEN, ODDANCHATRAM**

**(Recognized Under Section 2(f) and 12(B) of UGC Act 1956)**

**(Affiliated to Mother Teresa Women's University, Kodaikanal)**

**PG & RESEARCH DEPARTMENT OF MATHEMATICS**

**CURRICULUM FRAMEWORK AND SYLLABUS FOR**

**OUTCOME BASED EDUCATION IN**

**SYLLABUS FOR**

# M.Sc., MATHEMATICS

**FRAMED BY**

**MOTHER TERESA WOMEN'S UNIVERSITY,**

**KODAIKANAL**

**UNDER**

**CHOICE BASED CREDIT SYSTEM**

**2018-2021**

**Preamble:**

Mathematical Modelling plays a very important role in the entire process as it helps to analyse various variables and parameters of the system/subsystem under consideration, both in quantitative and qualitative terms. Recent developments in mathematical science and computers have led to improved modelling and understanding of situations in all areas of human activity including not only engineering, medicine, biology, ecology, geology, oceanography but in economics and a variety of other social sciences. The Department of Mathematics has been launched in Sakthi College of Arts and Science in the academic year 2009, with the introduction of B.Sc., (Mathematics) Degree Programme. It has met with the vertical growth by the introduction of M.Sc., (Mathematics) in 2010 and M.Phil., (Mathematics) in 2014.

The Department has highly qualified faculty members and support staff and is committed towards the development of innovative and handy ways of teaching at graduate, post graduate and research level and carrying out cutting edge research in various research fields. The department strives to nurture the young minds towards embracing various scientific challenges. Project work and problem sessions are encouraged to develop innovative and analytical approach to physics learning.

**Fixing the Learning Objectives:**

Since the Academic year 2018 – 2019, the learning objectives and outcomes of the programmes B.Sc., (Mathematics), M.Sc., (Mathematics) and M.Phil., (Mathematics) have been set, following the Bloom's Taxonomy Cognitive Domain. Accordingly, it is broken into six levels of learning objectives of each course. They are -

K1 / Knowledge = Remember

K2 / Comprehension = Understand

K3 / Application = Apply

K4 / Analysis = Analyze

K5 / Evaluation = Evaluate

K6 / Synthesis = Create

**Mapping COs with POs:**

For each programme, the Educational objectives and the Specific objectives are specified. The programme outcomes are designed according to the curriculum, teaching, learning and evaluation process. For each course, the definite outcomes are set, giving challenge to the

cognitive domain. The course outcomes are mapped with the programme outcomes. The performance of the stakeholders is assessed and the attainment rate is fixed, by using the measurements 'high', 'medium' and 'low'. The restructuring of the curriculum is done based on the rate of attainment.

**Institutional Objectives:**

The institution has certain definite Institutional Objectives to be attained.

- Skill Development & Capacity Building
- Women Empowerment
- Self-reliance
- Gender Equity & Integrity

**Programme Educational Objectives:**

The Programmes B.Sc., M.Sc., and M.Phil., (Mathematics) are offered with certain Specific Objectives.

- To identify the fundamental statements for the study of various areas of mathematics and define and describe them with clarity.
- To equip graduates with life – long learning skills, will allow them to successfully adapt to the evolving technologies throughout their professional careers.
- To graduates develop teaching skills, subject knowledge in the course of their study which will help them to shine in various fields.
- To discuss, formulate and analyze problems in Mathematics and identify the concepts and principles to solve them.
- To develop need based mathematics teaching learning resources.

**Mapping PEOs with IOs:**

| **Programme Educational Objectives** | **Institutional Objectives** | | | |
|---|---|---|---|---|
| **B.Sc. / M.Sc. / M.Phil., (Mathematics)** | **1** | **2** | **3** | **4** |
| **PEO1:** To identify the fundamental statements for the study of various areas of mathematics and define and describe them with clarity. | * | | | |
| **PEO2:** To equip graduates with life – long learning skills, will allow them to successfully adapt to the evolving technologies throughout their professional careers. | | * | | |
| **PEO3:** Graduates develop teaching skills, subject knowledge in | | | | |

| | | | | |
|---|---|---|---|---|
| the course of their study which will help them to shine in various fields. | | | * | |
| **PEO4:** To discuss, formulate and analyze problems in Mathematics and identify the concepts and principles to solve them. | | | | * |
| **PEO5:** To develop need based mathematics teaching learning resources. | | | * | |

- **Measuring: H – High; M – Medium; L – Low**

# M.Sc., MATHEMATICS

**Programme Outcomes: (POs)**

On completion of the M.Sc., (Mathematics) Programme, certain outcomes are expected from the learners.

**PO1:** Acquiring the Mathematical Knowledge and skills appropriate to professional activities and demonstrate highest standards of ethical issues in Mathematics.

**PO2:** Comprehending the effective reports and design documentation related to Mathematical research and literature make effective presentations.

**PO3:** Understanding of the fundamental axioms in Mathematics and capability of developing ideas based on them.

**PO4:** Applying the knowledge of Mathematical concepts in interdisciplinary fields.

**PO5:** Analyzing the challenging problems in mathematics and find appropriate solution..

**PO6:** Evaluating the ideas of mathematics for propagation of knowledge and popularization of mathematics in society.

**PO7:** Getting through competitive examinations such as NET, GATE, etc. and become professionals.

**ASSESSMENT PATTERN**

**CIA / QUESTION PATTERN & SCHEME**

| S.No | Section | Question Type | Marks Allotted |
|---|---|---|---|
| 1 | Part - A | Six questions in multiple choice pattern, testing K1 and K2 are to be given. Each question carries one mark. | 03X01 = 03 |
| 2 | Part - B | Two descriptive questions, with alternate options, testing K3 and K4, are to be given. Each question carries four marks. | 02X02 = 04 |
| 3 | Part - C | Two descriptive questions, testing K5 and K6, are to be given. Three questions are to be answered. Each question carries 15 marks. | 02X04 = 08 |
| 4 | | Assignment | 05 |
| 5 | | Seminar | 05 |
| | | Total Marks in CIA | 25 |

**CE / QUESTION PATTERN & SCHEME**

| S.No | Section | Question Type | Marks Allotted |
|---|---|---|---|
| 1 | Part - A | Ten questions in multiple choice pattern, testing K1 and K2 are to be given. From each unit, two questions must be taken. Each question carries one mark. | 10X1 = 10 |
| 2 | Part - B | Five descriptive questions, with alternate options, testing K3 and K4, are to be given. Each question carries four marks. Questions are taken in the given order.<br>Qtn. No. 11 (a) or (b) from Unit I<br>Qtn. No.12 (a) or (b) from Unit II<br>Qtn. No.13 (a) or (b) from Unit III<br>Qtn. No.14 (a) or (b) from Unit IV<br>Qtn. No.15 (a) or (b) from Unit V | 5X4 = 20 |
| 3 | Part - C | Six descriptive questions, testing K5 and K6, are to be given. Three questions are to be answered. Each question carries 15 marks. Questions are taken in the given order.<br>Qtn. No. 16 from Unit I<br>Qtn. No. 17 from Unit II<br>Qtn. No. 18 from Unit III<br>Qtn. No. 19 from Unit IV<br>Qtn. No. 20 from Unit V | 3X15 = 45 |
| | | Total Marks in CE | 75 |

**COMMON ACADEMIC STRUCTURE / M.Sc., MATHEMATICS / 2018 - 2021**

| Sem | Sub. Code | Title of the Course | Hrs | Credits | Marks | | |
|---|---|---|---|---|---|---|---|
| | | | | | CIA | CE | Total |
| I | PMTT11 | Part – III / Core – I / Linear Algebra | 6 | 5 | **25** | **75** | **100** |
| | PMTT12 | Part – III / Core – II / Real Analysis I | 6 | 5 | 25 | 75 | 100 |
| | PMTT13 | Part – III / Core – III / Differential Equations | 6 | 5 | 25 | 75 | 100 |
| | PMTT14 | Part – III / Core Practical – I / Graph Theory | 6 | 5 | 25 | 75 | 100 |
| | PMTE11 | Part – III / Elective-I | 6 | 5 | 25 | 75 | 100 |
| | | **Total** | **30** | **25** | | | **500** |
| II | PMTT21 | Part – III / Core – IV / Algebra | 6 | 5 | 25 | 75 | 100 |
| | PMTT22 | Part – III / Core – V / Real Analysis II | 6 | 5 | 25 | 75 | 100 |
| | PMTT23 | Part – III / Core – VI / Topology | 6 | 5 | 25 | 75 | 100 |
| | PMTT24 | Part – III / Core Practical – II / Optimization Techniques | 6 | 5 | 25 | 75 | 100 |
| | PMTE22 | Part – III / Elective-II | 6 | 5 | 25 | 75 | 100 |
| | | **Total** | **30** | **25** | | | **500** |
| III | PMTT31 | Part – III / Core – VII / Complex Analysis | 6 | 5 | 25 | 75 | 100 |
| | PMTT32 | Part – III / Core – VIII / Measure Theory | 6 | 5 | 25 | 75 | 100 |
| | PMTT33 | Part – III / Core – IX / Classical Dynamics | 6 | 5 | 25 | 75 | 100 |
| | PMTT34 | Part – III / Core Practical – III / Calculus of Variations and Integral Equations | 6 | 5 | 25 | 75 | 100 |
| | PMTE33 | Part – III / Elective-II | 6 | 5 | 25 | 75 | 100 |
| | | **Total** | **30** | **25** | | | **500** |
| IV | PMTT41 | Part – III / Core – X / Functional Analysis | 6 | 5 | 25 | 75 | 100 |
| | PMTT42 | Part – III / Core – XI / Differential Geometry | 6 | 5 | 25 | 75 | 100 |
| | PMTP43 | Project | 18 | 5 | 25 | 75 | 100 |
| | | **Total** | **30** | **15** | | | **300** |
| **Grand Total** | | | | **90** | | | **1800** |

**Programme:** M.Sc., **Subject:** Mathematics

**Semester:** I **Course:** Linear Algebra

**Course Type:** Core Paper – I **Credits:** 5

**Hours Required:** 6 Hrs / Week

**CIA:** 25 **CA:** 75

**Course Outcomes:**

After completion of the course, certain outcomes are expected from the learners.

| Description | Blooms' Taxonomy Level |
|---|---|
| Comprehending a competence with the basic ideas of linear Algebra including the concepts of vector spaces, inner product spaces, modules and linear transformations | Comprehension (Level 2) |
| Applying the theorems in the characteristics of linear spaces and linear transformations | Application ( Level 3) |
| Analysing the properties and theorems about linear spaces to specific mathematical structures that satisfy the linear space axioms | Analysis (Level 4) |
| Composing the clear and accurate proofs using the concepts of linear Algebra | Evaluation ( Level 5) |
| Appreciating the significance of vector spaces and linear transformations | Synthesis ( Level 6) |

## COURSE CONTENT

**Unit – I : Vector Spaces**

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

**Unit – II : Linear Transformations and Matrices**

Linear transformations, Null spaces, and Ranges – The matrix representation of a linear transformations – Composition of linear transformations and matrix multiplication – Invertibility and Isomorphism – The change of coordinate matrix – Dual spaces – Homogeneous linear differential equations with constant coefficients.

**Unit – III : Elementary Matrix Operations and Systems of Linear Equations**

Elementary matrix operations and Elementary matrices – The rank of matrix and matrix inverse

– Systems of linear equations theoretical aspects – Systems of linear equations – computational aspects

**Unit – IV : Determinants**

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

**Unit – V : Diagonalization**

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

**Books for Study:**

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

  Chapter 1 : (Sec1.1- Sec1.7).

  Chapter 2 : (Sec 2.1-Sec 2.7).

  Chapter 3 : (Sec3.1 - Sec3.4).

  Chapter 4 : (Sec4.1- Sec4.5).

  Chapter 5 : (Sec 5.1- Sec 5.4).

**Books for Reference:**


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

**Programme:** M.Sc., **Subject:** Mathematics

**Semester:** I **Course:** Real Analysis I

**Course Type:** Core Paper – II **Credits:** 5

**Hours Required:** 6 Hrs / Week

**CIA:** 25 **CA:** 75

**Course Outcomes:**

After completion of the course, certain outcomes are expected from the learners.

| Description | Blooms' Taxonomy Level |
|---|---|
| Understanding the fundamental properties of the real numbers that lead to the formal development of real analysis | Comprehension (Level 2) |
| Developing the real number system in the complex field and Euclidean spaces | Application ( Level 3) |
| Analysing the limits and how they are used in sequences, series, differentiation and integration | Analysis (Level 4) |
| Evaluating various mathematical proofs of basic results in Continuity and connectedness | Evaluation ( Level 5) |
| Appreciating how abstract ideas and various methods in The derivative of a real function can be applied to important practical problems. Exhibits rigorous mathematical proofs in derivatives of Higher order | Synthesis ( Level 6) |

## COURSE CONTENT

**Unit – I : The Real and Complex Number Systems**

Introduction, Ordered sets – Fields - The real field - The extended real number system - The complex field - Euclidean spaces.

**Unit – II : Basic Topology**

Finite - Countable and Uncountable sets - Metric spaces - Compact sets - Perfect sets - Connected sets.

**Unit – III : Numerical Sequences and Series**

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

**Unit – IV : Continuity**

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

**Unit – V : Differentiation**

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

**Books for Study:**

- Walter Rudin, **Principles of Mathematical Analysis**, 3rd Edition, McGraw – Hill International Book Company, Singapore, (1982).

  Units 1-5: Chapters: 1 – 5 (Including Appendix of chapter 1).

**Books for Reference:**


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

**Programme:** M.Sc., **Subject:** Mathematics

**Semester:** I **Course:** Differential Equations

**Course Type:** Core Paper – III **Credits:** 5

**Hours Required:** 6 Hrs / Week

**CIA:** 25 **CA:** 75

**Course Outcomes:**

After completion of the course, certain outcomes are expected from the learners.

| Description | Blooms' Taxonomy Level |
|---|---|
| Gaining knowledge of the elements of Partial Differential Equations | Knowledge (Level 1) |
| Comprehending the first order differential equations selecting from a variety of techniques | Comprehension (Level 2) |
| Understanding a variety of second order differential equations, selecting from several techniques | Comprehension (Level 2) |
| Applying the series solutions (and approximations) for second order linear differential equations, both at ordinary points and at regular singular point | Application ( Level 3) |
| Investigating the boundary values of problems and pointing out its significance | Evaluation ( Level 5) |

## COURSE CONTENT

**Unit – I :**

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

**Unit – II :**

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

**Unit – III :**

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

**Unit – IV :**

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

**Unit – V :**

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

**Books for Study:**

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

  Unit I Chapter 3: Sections 15, 16, 19 and Chapter 5: Sections 25 to 27

  Unit II Chapter 5: Sections 28 to 31 and Chapter 6: Sections 32 to 35

  Unit III Chapter 7: Sections 37, 28 and Chapter 11: Sections 55, 56

  Unit IV Chapter 4: Sections 22 to 24

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

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

**Books for Reference:**


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

**Programme:** M.Sc., **Subject:** Mathematics

**Semester:** I **Course:** Graph Theory

**Course Type:** Core Paper – IV **Credits:** 5

**Hours Required:** 6 Hrs / Week

**CIA:** 25 **CA:** 75

**Course Outcomes:**

After completion of the course, certain outcomes are expected from the learners.

| Description | Blooms' Taxonomy Level |
|---|---|
| Gaining knowledge of Graph Theory with applications | |
| Understanding of some network and colouring in Graphs | Comprehension (Level 2) |
| Applying the atomic variable | Application ( Level 3) |
| Analysing the concepts of connectivity, Blocks and Hamilton cycles in the real life | Analysis (Level 4) |
| Evaluating the concept and familiar with the concepts of colouring develop the reader to apply in day today life | Evaluation ( Level 5) |

## COURSE CONTENT

**Unit – I :**

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

**Unit – II :**

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

**Unit – III :**

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

**Unit – IV :**

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

**Unit – V :**

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

**Books for Study:**

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

  Unit I : (chapter 1 : 1.1 – 1.7 and chapter 2 : 2.1 – 2.4).

  Unit II : (chapter 3 : 3.1 – 3.2 and chapter 4 : 4.1 – 4.4).

  Unit III: (chapter 5 : 5.1 – 5.3 and chapter 6 : 6.1 – 6.2).

  Unit IV: (chapter 7 : 7.1 – 7.3 and chapter 8 : 8.1 – 8.5).

  Unit V : (chapter 9 : 9.1 – 9.7 and chapter 10 : 10.1 – 10.3).

**Books for Reference:**


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

**Programme:** M.Sc., **Subject:** Mathematics

**Semester:** I **Course:** Probability Theory and Statistics

**Course Type:** Major Elective - I **Credits:** 5

**Hours Required:** 6 Hrs / Week

**CIA:** 25 **CA:** 75

**Course Outcomes:**

After completion of the course, certain outcomes are expected from the learners.

| Description | Blooms' Taxonomy Level |
|---|---|
| Gaining knowledge of the concepts of Mathematical Statistics | Knowledge (Level 1) |
| Comprehending the basic concepts of statistics, probability and random variables | Comprehension (Level 2) |
| Applying the concepts in finding the moments of the distributions | Application ( Level 3) |
| Identifying the type of the distribution and estimation | Analysis (Level 4) |
| Evaluating the basics of sampling distribution theory | Evaluation ( Level 5) |

## COURSE CONTENT

**Unit – I : Theory of Probability**

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

**Unit – II : Moment Generating Function**

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

**Unit – III : Distributions**

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

**Unit – IV : Estimation**

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

**Unit – V : Classifications**

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

**Books for Study:**

- P.R.Vital , Mathematical Statistics, Margham publications, Edition 2012.

  Unit I - Chapter 1: 1.4 – 1.48 and Chapter 2 : 2.1 – 2.33

  Unit II- Chapter 3: 3.1 – 3.18, Chapter 5, Chapter 6, Chapter 8, Chapter 9 and Chapter 11

  Unit III- Chapter 15, Chapter 16, Chapter 17, Chapter 18, Chapter 19,Chapter 20, and Chapter 22

  Unit IV- Chapter 23

  Unit V -Chapter 26 and Chapter 28.

**Books for Reference:**


- Robert V. Hogg & Allen T. Craig, Introduction to Mathematical Statistics, 5th Edition, Pearson Education, Singapore, 2002.
- Irwin Miller &Marylees Miller, John E. Freund‘s Mathematical Statistics, 6th Edition, Pearson Education, New Delhi, 2002.
- John E. Freund, Mathematical Statistics, 5 th edition, Prentice Hall India, 1994.
- S.M. Ross, Introduction to Probability Models, Academic Press, India, 2000.

**Programme:** M.Sc., **Subject:** Mathematics

**Semester:** II **Course:** Algebra

**Course Type:** Core Paper – V **Credits:** 5

**Hours Required:** 6 Hrs / Week

**CIA:** 25 **CA:** 75

**Course Outcomes:**

After completion of the course, certain outcomes are expected from the learners.

| Description | Blooms' Taxonomy Level |
|---|---|
| Understanding the basic ideas of algebra including the concepts of direct products, finitely generated abelian groups, Fields , extension fields , Galois theory and finite fields | Comprehension (Level 2) |
| Comprehending the concepts of Permutation | Comprehension (Level 2) |
| Applying the knowledge in solving problems in polynomials over the rational field | Application ( Level 3) |
| Analysing the knowledge of the structures of fields ,extension fields and finite fields | Analysis (Level 4) |
| Evaluating the logical mathematical arguments and Solvability by radicals | Evaluation ( Level 5) |

## COURSE CONTENT

**Unit – I :**

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

**Unit – II :**

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

**Unit – III :**

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

**Unit – IV :**

Extension fields - Roots of polynomials - More about roots - Finite fields.

**Unit – V :**

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

**Books for Study:**

- N. Herstein, Topics in Algebra, 2nd edition, John Wiley & Sons, Singapore, 2006.

Unit 1 Chapter 2: Sections 2.5, 2.6, 2.7, 2.8, 2.9, 2.10

Unit 2 Chapter 2: Sections 2.11, 2.12, 2.13, 2.14

Unit 3 Chapter 3: Sections 3.7, 3.8, 3.9, 3.10, 3.11

Unit 4 Chapter 5: Sections 5.1, 5.3, 5.5 & Chapter 7: Section 7.1

Unit 5 Chapter 5: Sections 5.6, 5.7, 5.8

**Books for Reference:**


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

**Programme:** M.Sc., **Subject:** Mathematics

**Semester:** II **Course:** Real Analysis - II

**Course Type:** Core Paper – VI **Credits:** 5

**Hours Required:** 6 Hrs / Week

**CIA:** 25 **CA:** 75

**Course Outcomes:**

After completion of the course, certain outcomes are expected from the learners.

| Description | Blooms' Taxonomy Level |
|---|---|
| Understanding the fundamental properties of the real numbers that lead to the formal development of real analysis | Comprehension (Level 2) |
| Applying the rigorous arguments developing the theory underpinning real analysis in the Stone-Weierstrass theorem | Application ( Level 3) |
| Demonstrating an understanding of limits and how they are used in sequences, series, differentiation and integration | Analysis (Level 4) |
| Evaluating the various mathematical proofs of basic results in implicit function theorem | Evaluation ( Level 5) |
| Appreciating the abstract ideas and various methods in mathematical analysis can be applied to important practical problems. Exhibits rigorous mathematical proofs in real analysis like inverse function theorem and the implicit function theorem | Synthesis ( Level 6) |

## COURSE CONTENT

**Unit – I : The Riemann-Stieltjes integral**

Definition and existence of the integral - Properties of the integral - Integration and differentiation - Integration of vector valued functions – Rectifiable Curves.

**Unit – II : Sequences and series of functions**

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

**Unit – III : Some special functions**

Power series - The exponential and Logarithmic functions - The trigonometric functions - The algebraic completeness of the complex field - Fourier Series - The Gamma functions.

**Unit – IV : Functions of several variables**

Linear transformations – Differentiation - The contraction principle - The inverse function theorem.

**Unit – V :**

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

**Books for Study:**

- Walter Rudin, Principles of Mathematical Analysis, 3rd Edition, McGraw – Hill International Book Company, Singapore, 1982.

  Unit 1: Chapter 6, Unit 2: Chapter 7,

  Unit 3: Chapter 8, Unit 4, 5: Chapter 9.

**Books for Reference:**


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

**Programme:** M.Sc., **Subject:** Mathematics

**Semester:** II **Course:** Topology

**Course Type:** Core Paper – VII **Credits:** 5

**Hours Required:** 6 Hrs / Week

**CIA:** 25 **CA:** 75

**Course Outcomes:**

After completion of the course, certain outcomes are expected from the learners.

| Description | Blooms' Taxonomy Level |
|---|---|
| Understanding the concept of topological spaces and continuous functions, concept of product topology and quotient topology | Comprehension (Level 2) |
| Applying the concepts of distance between two sets, connectedness, denseness, compactness and separation axioms | Application ( Level 3) |
| Analyzing the concepts to read and write theorem proofs in topology | Analysis (Level 4) |
| Evaluating to determine that a given point in a topological space is either a limit point of not for a given subset of a topological space. | Evaluation ( Level 5) |
| Evaluating theorem proofs to do variety of examples and counter examples in topology | Evaluation ( Level 5) |

## COURSE CONTENT

**Unit – I : Topological Spaces and Continuous Functions**

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

**Unit – II : Metric Topology**

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

**Unit – III : Compactness**

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

**Unit – IV : Countability and Separation Axioms**

The Separation Axioms- Normal Spaces- The Urysohn Lemma- The Urysohn Metrization Theorem.

**Unit – V : Extension Theorem**

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

**Books for Study:**

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

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

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

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

  Unit IV: Chapter 4- Section: 30- Section 34

  Unit V: Chapter 5- Section: 37, 38- Chapter 6: Section 39, 40

**Books for Reference:**

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

**Programme:** M.Sc., **Subject:** Mathematics

**Semester:** II **Course:**Optimization Techniques

**Course Type:** Core Paper – VIII **Credits:** 5

**Hours Required:** 6 Hrs / Week

**CIA:** 25 **CA:** 75

**Course Outcomes:**

After completion of the course, certain outcomes are expected from the learners.

| Description | Blooms' Taxonomy Level |
|---|---|
| Comprehending the importance and value of Operations Research and mathematical modeling in solving practical problems in industry | Comprehension (Level 2) |
| Applying the variables for formulating complex mathematical models in management science, industrial engineering and Transportation science and in real life | Application ( Level 3) |
| Analyzing a managerial decision problem and application of Dynamic Programming: Capital Budgetting Problem | Analysis (Level 4) |
| Evaluating a design, improve and operate complex systems in the best possible way through empirical Queueing Models | Evaluation ( Level 5) |
| Appreciating the significance of Lagrangean Method – Kuhn-Tucker Method | Synthesis ( Level 6) |

## COURSE CONTENT

**Unit – I : Integer Programming**

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

**Unit – II : Inventory Control**

Introduction – Models of Inventory – Operation of Inventory System – Quantity Discount – Implementation of Purchase Inventory Model

**Unit – III : Dynamic Programming**

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

**Unit – IV : Queueing Theory**

Introduction – Terminologies of Queueing System – Empirical Queueing Models – Simulation.

**Unit – V : Non Linear Programming**

Introduction – Lagrangean Method – Kuhn-Tucker Method – Quadratic Programming – Separable Programming – Chance-Constrained Programming or Stochastic Programming.

**Books for Study:**

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

  Unit - I- Chapter 6- Sections 6.1-6.5

  Unit - II- Chapter 7- Sections 7.1-7.5

  Unit - III- Chapter 8- Sections 8.1-8.2

  Unit - IV- Chapter 9- Sections 9.1-9.4

  Unit - V- Chapter 17- Sections 17.1-17.6

**Books for Reference:**


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

**Programme:** M.Sc., **Subject:** Mathematics

**Semester:** II **Course:**Automata Theory

**Course Type:** Major Elective – II **Credits:** 5

**Hours Required:** 6 Hrs / Week

**CIA:** 25 **CA:** 75

**Course Outcomes:**

After completion of the course, certain outcomes are expected from the learners.

| Description | Blooms' Taxonomy Level |
|---|---|
| Understanding the basic concepts in Lattices , formal language and automata theory | Comprehension (Level 2) |
| Applying the abstract models of computing, including deterministic (DFA), non-deterministic (NFA), Push Down Automata(PDA ) | Application ( Level 3) |
| Analysing theoretical knowledge relate practical problems to languages and automata | Analysis (Level 4) |
| Evaluating the logic and methods behind grammars and recognizers for different formal languages | Evaluation ( Level 5) |
| Evaluating the structure of a given formal language using regular expressions and context free grammars and implementation of a lexical analyzer. | Evaluation ( Level 5) |

## COURSE CONTENT

**Unit – I : Finite Automata and Regular expressions**

Definitions and examples – Deterministic and Nondeterministic finite Automata – Finite Automata with –moves.

**Unit – II : Context free grammar**

Regular expressions and their relationship with automation – Grammar – Ambiguous and unambiguous grammars – Derivation trees – Chomsky Normal form.

**Unit – III : Pushdown Automaton**

Pushdown Automaton – Definition and examples – Relation with Context free languages.

**Unit – IV : Finite Automata and lexical analysis**

Role of a lexical analyzer – Minimizing the number of states of a DFA – Implementation of a lexical analyzer.

**Unit – V : Basic parsing techniques**

Parsers – Bottom up Parsers – Shift reduce – operator precedence – Top down Parsers – Recursive descent – Predictive parsers.

**Books for Study:**

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

  Unit I: Chapter 2: Sections2.1-2.4

  Unit II: Chapter 2, Section 2.5, Chapter 4, Sections 4.1-4.3, 4.5,4.6

  Unit III: Chapter 5: Section 5.2, 5.3

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

  Unit IV: Chapter 3: Section 3.1-3.8

  Unit V: Chapter 5: Section 5.1-5.5

**Books for Reference:**

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

**Programme:** M.Sc., **Subject:** Mathematics

**Semester:** III **Course:** Complex Analysis

**Course Type:** Core Paper – IX **Credits:** 5

**Hours Required:** 6 Hrs / Week

**CIA:** 25 **CA:** 75

**Course Outcomes:**

After completion of the course, certain outcomes are expected from the learners.

| Description | Blooms' Taxonomy Level |
|---|---|
| Comprehending the fundamental properties of the complex numbers that lead to the development of complex analysis | Comprehension (Level 2) |
| Applying and understand about limits and to know how they are used in series and problems | Application ( Level 3) |
| Analyzing functions of complex variable in terms of continuity, differentiability and analyticity. Apply Cauchy-Riemann equations and harmonic functions to solve problem | Analysis (Level 4) |
| Evaluating the line integrals, curve integrals, singularities and determine the values of integrals using residues. | Evaluation ( Level 5) |
| Creating the rigorous arguments developing the theory underpinning complex analysis | Synthesis ( Level 6) |

## COURSE CONTENT

**Unit – I :**

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

**Unit – II :**

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

**Unit – III :**

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

**Unit – IV:**

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

**Unit – V :**

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

**Books for Study:**

- S.Ponnusamy, Foundations of Complex Analysis, 2rd Edition, Narosa Publishing House Ltd, Chennai, 2005.

  Unit I - Chapter 1: 1.6 and Chapter 2: 2.1 – 2.4

  Unit II – Chapter 3: 3.1 – 3.6

  Unit III - Chapter 4: 4.1 – 4.8

  Unit IV- Chapter 4: 4.9 –4.12 and Chapter 5: 5.1-5.3

  Unit V – Chapter 6: 6.1 – 6.7

**Books for Reference:**


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

**Programme:** M.Sc., **Subject:** Mathematics

**Semester:** III **Course:** Measure Theory

**Course Type:** Core Paper – X **Credits:** 5

**Hours Required:** 6 Hrs / Week

**CIA:** 25 **CA:** 75

**Course Outcomes:**

After completion of the course, certain outcomes are expected from the learners.

| Description | Blooms' Taxonomy Level |
|---|---|
| Gaining knowledge of the concepts of Measure and Integration | Knowledge (Level 1) |
| Understanding the basics axioms for the real numbers, natural and rational numbers as subset. | Comprehension (Level 2) |
| Demonstrate the basic concepts underlying the definition of the general Lebesgue integral | Application ( Level 3) |
| Applying the concepts of Borel sets, measurable functions, differentiation of monotone functions | Application ( Level 3) |
| Analyzing about the Signed Measure and the Hahn Decomposition, integral of a non-negative function, functions of bounded variation | Analysis (Level 4) |

## COURSE CONTENT

**Unit – I :**

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

**Unit – II :**

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

**Unit – III :**

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

**Unit – IV :**

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

**Unit – V :**

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

**Books for Study:**

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

  Unit – I: Chapter II: Sections 2.1 to 2.5

  Unit – II: Chapter III: Sections 3.1 to 3.4

  Unit – III: Chapter V: Sections 5.1 to 5.6

  Unit – IV: Chapter VII: Sections 7.1 and 7.2, Chapter VIII: Sections 8.1 and 8.2

  Unit – V: Chapter X: Sections 10.1 and 10.2

**Books for Reference:**


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

**Programme:** M.Sc., **Subject:** Mathematics

**Semester:** III **Course:** Clasical Dynamics

**Course Type:** Core Paper – XI **Credits:** 5

**Hours Required:** 6 Hrs / Week

**CIA:** 25 **CA:** 75

**Course Outcomes:**

After completion of the course, certain outcomes are expected from the learners.

| Description | Blooms' Taxonomy Level |
|---|---|
| Comprehending the knowledge of core principles in dynamics | Comprehension (Level 2) |
| Applying the variation principle for real physical situations | Application ( Level 3) |
| Analysing the complex and difficult problems of classical dynamics in a systematic way | Analysis (Level 4) |
| Evaluating the existing symmetries and the corresponding integrals of motion and analyze the qualitative nature of dynamics | Evaluation ( Level 5) |
| Creating the problem solving skills (approach, estimation, computation, and analysis) of classical mechanics in various contexts such as mechanical engineering, astrophysics, and biophysics | Synthesis ( Level 6) |

## COURSE CONTENT

**Unit – I : Introductory concepts**

The mechanical system - Generalised Coordinates - constraints - virtual work - Energy and momentum.

**Unit – II : Lagrange's equation**

Derivation and examples - Integrals of the Motion

**Unit – III : Hamilton's equations**

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

**Unit – IV : Hamilton - Jacobi Theory**

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

**Unit – V : Canonical Transformations**

Differential forms and Generating functions – Special Transformations – Lagrange and Poisson Brackets.

**Books for Study:**

- Donald T. Greenwood, **Classical Dynamics**, PHI Pvt. Ltd., New Delhi, 1985.

  Unit I - Chapter: 1.1-1.5

  Unit II - Chapter: 2.1-2.4

  Unit III - Chapter: 3.1,3.2 and 3.4 (3.3 Omitted)

  Unit IV - Chapter: 4.1-4.4

  Unit V - Chapter: 5.1-5.3

**Books for Reference:**


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

**Programme:** M.Sc., **Subject:** Mathematics

**Semester:** III **Course:** Calculus of Variations and Integral Equations

**Course Type:** Core Paper – XII **Credits:** 5

**Hours Required:** 6 Hrs / Week

**CIA:** 25 **CA:** 75

**Course Outcomes:**

After completion of the course, certain outcomes are expected from the learners.

| Description | Blooms' Taxonomy Level |
|---|---|
| Understanding the competence with the basic ideas of The Method of Variations in Problems with fixed Boundaries | Comprehension (Level 2) |
| Applying the Euler's finite difference method ,The Ritz method and Kantorovich's method in Variational Problems | Application ( Level 3) |
| Analysing the functional dependent on the functions of several independent variables | Analysis (Level 4) |
| Evaluating the accurate proofs using the concepts of reduction to a system of Algebraic equations | Evaluation ( Level 5) |

## COURSE CONTENT

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

Variation and its properties - Euler's equation - Functionals of the form $\int F(x,y1,y2,\ldots yn,y1',y2',\ldots yn')dx$, Functionals dependent on higher order derivatives - Functionals dependent on the functions of several independent variables - Variational problems in parametric form - Some applications.

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

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

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

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

**Integral Equations:**

**Unit – IV : Linear Integral Equations**

Definition, Regularity conditions – special kind of kernels – eigen values and eigen functions – convolution Integral – the inner and scalar product of two functions – Notation – reduction to a

system of Algebraic equations – examples – Fredholm alternative - examples – an approximate method.

**Unit – V : Method of successive approximations**

: Iterative scheme – examples – Volterra Integral equation – examples – some results about the resolvent kernel. Classical Fredholm Theory: the method of solution of Fredholm – Fredholm‘s first theorem – second theorem – third theorem.

**Books for Study:**

- L. Elsgolts, Differential Equations and The Calculus Of Variations, MIR publishers, Moscow 1970.

  Unit – I Chapter 6

  Unit – II Chapter 8

  Unit – III Chapter 10

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

  Unit – IV Chapters 1 and 2 [1]

  Unit – V Chapters 3 and 4

**Books for Reference:**

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

**Programme:** M.Sc., **Subject:** Mathematics

**Semester:** III **Course:**Non Linear Differential Equations

**Course Type:** Major Elective – III **Credits:** 5

**Hours Required:** 6 Hrs / Week

**CIA:** 25 **CA:** 75

**Course Outcomes:**

After completion of the course, certain outcomes are expected from the learners.

| Description | Blooms' Taxonomy Level |
|---|---|
| Comprehending the basic concepts linear approximation at equilibrium points | Comprehension (Level 2) |
| Applying the concepts amplitude Perturbation for the pendulum equation | Application ( Level 3) |
| Identifying the application of Floquet Theory | Analysis (Level 4) |
| Evaluating the basics Stability and Poincare stability | Evaluation ( Level 5) |
| Creating on estimating the Perturbation Method and Fourier series. | Synthesis ( Level 6) |

## COURSE CONTENT

**Unit – I :**

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

**Unit – II :**

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

**Unit – III :**

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

**Unit – IV :**

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

**Unit – V :**

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

**Books for Study:**

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

**Books for Reference:**

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

**Programme:** M.Sc., **Subject:** Mathematics

**Semester:** IV **Course:**Functional Analysis

**Course Type:** Core Paper – XIII **Credits:** 5

**Hours Required:** 6 Hrs / Week

**CIA:** 25 **CA:** 75

**Course Outcomes:**

After completion of the course, certain outcomes are expected from the learners.

| Description | Blooms' Taxonomy Level |
|---|---|
| Gaining knowledge of the concepts of Functional Analysis | Knowledge (Level 1) |
| Understanding the properties of normed linear spaces and construct examples of such spaces | Comprehension (Level 2) |
| Applying the basic theoretical techniques to analyze linear functionals and operators on Banach and Hilbert spaces | Application ( Level 3) |
| Analysing the Finite-Dimensional Spectral Theory survey of the situation | Analysis (Level 4) |
| Evaluating the theorems to do problems | Evaluation ( Level 5) |

## COURSE CONTENT

**Unit – I : Banach spaces**

The definitions and some examples-Continuous linear transformations-The Hahn-Banach Theorem- The Natural imbedding of N in N**- The Open mapping theorem-The Conjugate of an Operator.

**Unit – II : Hilbert Spaces**

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

**Unit – III : Finite-Dimensional Spectral Theory**

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

**Unit – IV : General Preliminaries on Banach Algebras**

The Definition and some examples-Regular and singular elements-Topological divisors of zero-The Spectrum-The formula for the spectrum radius-The radical and semi-simplicity.

**Unit – V : The Structure of Commutative Banach Algebras**

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

**Books for Study:**

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

  Unit I: Chapter 9 Unit II: Chapter 10

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

**Books for Reference:**

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

**Programme:** M.Sc., **Subject:** Mathematics

**Semester:** IV **Course:**Differential Geometry

**Course Type:** Core Paper – XIV **Credits:** 5

**Hours Required:** 6 Hrs / Week

**CIA:** 25 **CA:** 75

**Course Outcomes:**

After completion of the course, certain outcomes are expected from the learners.

| Description | Blooms' Taxonomy Level |
|---|---|
| Comprehending the concise arguments involving basic notions and constructions of 2-dimensional Riemannian geometry, curves and torsion | Comprehension (Level 2) |
| Applying the important types of curves in surfaces, including principal curves, asymptotic curves and geodesics using fundamental existence theorem for space curves | Application ( Level 3) |
| Analyzing some standard examples in geometry, such as surfaces of constant Gaussian curvature, compact and non -compact surfaces, and surfaces of revolution | Analysis (Level 4) |
| Evaluating the Gaussian and mean curvatures using variety of methods including patch computations . | Evaluation ( Level 5) |
| Evaluating the Differential equations of geodesics using normal property | Evaluation ( Level 5) |

## COURSE CONTENT

**Unit – I :**

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

**Unit – II :**

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

**Unit – III :**

The first fundamental form and local intrinsic properties of a surface: Definition of a surface - Nature of points on a surface - Representation of a surface - Curves on surfaces - Tangent plane

and surface normal - The general surfaces of revolution – Helicoids - Metric on a surface - The first fundamental form - Direction coefficients on a surface.

**Unit – IV :**

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

**Unit –V :**

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

**Books for Study:**

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

  Unit I: Sections 1.3-1.7, 1.10-1.12

  Unit II: Sections 1.13-1.18

  Unit III: Sections 2.2-2.10

  Unit IV: Sections 2.11-2.15, 3.2-3.6

  Unit V: Sections 3.7-3.12

**Books for Reference:**

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

**Programme:** M.Sc., **Subject:** Mathematics

**Semester:** IV **Course:** Project

**Course Type:** Project **Credits:** 5

**Hours Required:** 18 Hrs / Week

**CIA:** 25 **CA:** 75

## RULES AND REGULATION OF THE PROJECT

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

Internal: 25 marks

External: 75 marks