PERIYAR UNIVERSITY

PERIYAR PALKALAI NAGAR

SALEM - 11

M.Sc. Branch–I (B): Mathematics

(SEMESTER PATTERN)

(Under Choice Based Credit System)

(For University Department)

REGULATIONS AND SYLLABUS

(Candidates admitted from 2015-2016 onwards)

PERIYAR UNIVERSITY, SALEM –11

M.Sc. BRANCH 1(B) - MATHEMATICS - CHOICE BASED CREDIT SYSTEM (CBCS) REGULATIONS AND SYLLABUS

(For the candidates admitted from 2015-2016)

1. DURATION OF THE PROGRAMME

The two-year postgraduate programme in M.Sc. Mathematics consists of four semesters under Choice Based Credit System.

2. ELIGIBILITY

A candidate who has passed B.Sc. Degree Examination in Branch I- Mathematics and Mathematics (CA) of this University or an examination of some other university accepted by the syndicate as equivalent there to shall be permitted to appear and qualify for the M.Sc. Mathematics (CBCS) Degree Examination of this university after a course of two academic years in the Department of Mathematics of Periyar University.

3. DISTRIBUTION OF CREDIT POINTS AND MARKS

The minimum credit requirement for a two year Master's programme shall be 92 Credits. The break-up of credits for the programme is as follows:

- Core Courses : Minimum 64 credits
- Elective Courses : Minimum 16 credits
- Supportive Courses : Minimum 04 credits
- Project : 08 credits

4. COURSE OF STUDY

The courses of study for the degree shall be in Branch I(B) - Mathematics (Choice Based Credit System) with internal assessment according to a syllabi prescribed from time to time. The **Internal Assessment** is distributed to tests, seminar, assignment and attendance as **10, 05, 05** and **05** marks, respectively.

Total Marks	: 2100
For Each Paper	: 100 (Int. 25 + Ext. 75)
Dissertation	: 200 (Internal Valuation 50 + External Valuation 50 Joint Viva Voce 50 + 50]

5. STRUCTURE OF THE COURSE

S. No	COURSE CODE	TITLE OF THE COURSE	CREDITS	MARKS
I SEMESTER				
1.	15UPMAT1C01	Linear Algebra	5	100
2.	15UPMAT1C02	Real Analysis	5	100
3.	15UPMAT1C03	Ordinary Differential Equations	5	100
4.	15UPMAT1C04	Mechanics	4	100
5.		Elective Course - I	4	100
II SEMESTER				
6.	15UPMAT1C05	Algebra	5	100
7.	15UPMAT1C06	Advanced Real Analysis	5	100
8.	15UPMAT1C07	Partial Differential Equations	5	100
9.		Elective Course – II	4	100
10.		Supportive Course	4	100
11.	06PHR01	Human Rights	2	100
III SEMESTER				
12.	15UPMAT1C08	Topology	5	100
13.	15UPMAT1C09	Complex Analysis	5	100
14.	15UPMAT1C10	Graph Theory	4	100
15.	15UPMAT1C11	Probability Theory	4	100
16.		Elective course - III	4	100
IV SEMESTER				
17.	15UPMAT1C12	Measure Theory and Integration	5	100
18.	15UPMAT1C13	Functional Analysis	5	100
19.	15UPMAT1C14	Dissertation	8	200
20.		Elective Course - IV	4	100
TOTAL			**92**	**2100**

ELECTIVE COURSES

S.No	COURSE CODE	TITLE OF THE COURSE	CREDITS
1.	15UPMAT1E01	Discrete Mathematics	4
2.	15UPMAT1E02	Harmonic Analysis	4
3.	15UPMAT1E03	Difference Equations	4
4.	15UPMAT1E04	Numerical Analysis	4
5.	15UPMAT1E05	Methods of Applied Mathematics	4
6.	15UPMAT1E06	Optimization Techniques	4
7.	15UPMAT1E07	Combinatorial Mathematics	4
8.	15UPMAT1E08	Fuzzy Sets and their Applications	4
9.	15UPMAT1E09	Representation Theory	4
10.	15UPMAT1E10	Calculus of Variations and Integral Equations	4
11.	15UPMAT1E11	Computer Programming Lab	4
12.	15UPMAT1E12	Non Commutative Algebra	4
13.	15UPMAT1E13	Commutative Algebra	4
14.	15UPMAT1E14	Control Theory	4
15.	15UPMAT1E15	Stochastic Differential Equations	4
16.	15UPMAT1E16	Distribution Theory	4
17.	15UPMAT1E17	Number Theory	4
18.	15UPMAT1E18	Differential Geometry	4
19.	15UPMAT1E19	Topology – II	4
20.	15UPMAT1E20	Nonlinear Differential Equations	4
21	15UPMAT1E21	Advanced Partial Differential Equations	4

SUPPORTIVE COURSES

S.No	COURSE CODE	TITLE OF THE COURSE	CREDITS
1.	15UPMAT1S01	Applied Mathematics – I	4
2.	15UPMAT1S02	Applied Mathematics – II	4
3.	15UPMAT1S03	Numerical & Statistical Methods	4
4.	15UPMAT1S04	Statistics	4

6. EXAMINATION:

For the purpose of uniformity, particularly for interdepartmental transfer of credits, there shall be a uniform pattern of examination to be adopted by all the teachers offering courses. There shall be three tests, one seminar and one assignment for internal evaluation and End semester examination during each semester.

The distribution of marks for internal evaluation and End Semester Examination shall be 25 marks and 75 marks, respectively. Further, distribution of internal marks shall be 10 marks for test, 5 marks for seminar, 5 marks for assignment and 5 marks for attendance, respectively. The average of the highest two test marks out of the three internal tests should be taken for Internal Assessment.

7. QUESTION PAPER PATTERN

(a) Question paper pattern for Theory Examination

Time: Three Hours **Maximum Marks:** 75

Part – A (10 X 2 = 20 Marks)

Answer **ALL** Questions

(Two Questions from each unit)

Part – B (5 X 5 = 25 Marks)

Answer **ALL** Questions

(Two Questions from each unit with internal choice)

Part – C (3 X 10 = 30 Marks)

Answer any **Three** questions out of **Five** questions

(One question from each unit)

(b) Question paper pattern for Practical Examination

Time: 3 Hours Maximum: **100** (Internal: 40 + External: 60) Marks

Practical Examination : **60** Marks (Exam: 50 Marks, Record: 10 Marks)

Passing Minimum : **30** Marks (Aggregate of examination and Record)
(No passing minimum for records)

There will be one question with or without subsections to be asked for the practical examination. Every question should be chosen from the question bank prepared by the examiner(s). A question may be used for at most three students in a batch.

8. PASSING MINIMUM

A candidate who has secured a minimum of 50% marks in all the courses (including practical) prescribed in the programme and earned minimum of 92 credits will be considered to have passed the Master's programme.

For the Practical paper, a minimum of 30 marks out of 60 marks in the University examination and the record notebook taken together is necessary for a pass. There is no passing minimum for the record notebook. However submission of record notebook is a must.

For the Project work and viva-voce a candidate should secure 50% of the marks for pass. The candidate should attend viva-voce examination to secure a pass in the Project.

9. COMMENCEMENT OF THIS REGULATION

These regulations shall take effect from the academic year 2015-16, that is, for students who are admitted to the first year of the programme during the academic year 2015-16 and thereafter.

10. DISSERTATION

(a) Topic:

The topic of the dissertation shall be assigned to the candidate at the beginning of third semester and a copy of the same should be submitted to the University for approval.

(b) No. of copies of project/dissertation:

The students should prepare three copies of dissertation and submit the same for the evaluation by Examiners. After evaluation one copy is to be retained in the University Library, one in the Department Library and one with the student.

Format for the preparation of project work:

(a) Title page

(b) Bonafide Certificate

(c) Acknowledgement

(d) Table of contents

CONTENTS

Format of the Title Page:

TITLE OF THE PRJOCET / DISSERTATION

Project/Dissertation Submitted in partial fulfillment of the requirement for the award of the

Degree of Master of Science in

MATHEMATICS

(Under Choice Based Credit System)

to the Periyar University, Periyar Palkalai Nagar, Salem – 636 011.

By

Students Name :

Register Number :

Department :

Year :

Format of the Certificate

CERTIFICATE

This is to certify that the dissertation entitled .....submitted in partial fulfillment of the requirement for the award of the Degree of Master of Science in **MATHEMATICS (Under Choice Based Credit System)** to the Periyar University, Periyar Palkalai Nagar, Salem is a record of bonafide research work carried out by ..... under my supervision and guidance and that no part of the dissertation has been submitted for the award of any degree, diploma, fellowship or other similar titles or prizes and that the work has not been published in part or full in any scientific or popular journals or magazines.

Date:

Place: Signature of the Guide

Signature of the Head of the Department

15UPMAT1C01	LINEAR ALGEBRA	CREDITS: 5

UNIT I: Linear Transformations

The Algebra of Linear transformations, characteristic roots, Similarity of linear transformations, Invariant subspaces and Matrices.

UNIT II: Triangular Canonical Form

Reduction to triangular forms, Nilpotent transformations, Index of nilpotency and Invariant of Nilpotent transformation.

UNIT III: Jordan Canonical Form

Jordan blocks and Jordan forms, Modules – Cyclic modules – Fundamental theorem on modules – over PID.

UNIT IV: Rational Canonical Form

Rational canonical form, trace, transpose and Determinants.

UNIT V: Real Quadratic Forms

Hermitian, Unity and Normal transformations – Real quadratic forms.

TEXT BOOK:

I.N. Herstein, Treatment and Contents as in Topics in Algebra, Wiley Eastern Ltd., New Delhi, (1975).

UNIT I: Sections - 6.1, 6.2, and 6.3
UNIT II: Sections - 6.4 and 6.5
UNIT III: Sections - 6.6 and 4.5
UNIT IV: Sections - 6.7, 6.8 and 6.9
UNIT V: Sections - 6.10 and 6.11

Books for Supplementary Reading and Reference:

1. M. Artin, Algebra, Prentice-Hall of India, 1991
2. N. Jacobson, Basic Algebra, Volume I & II, W.H.Freeman, 1980.
3. S. Lang, Algebra, 3rd edition, Addison-Wesley.
4. P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul: Basic Abstract Algebra (2nd Edition) Cambridge University Press, Indian edition, 1997.

15UPMAT1C02	REAL ANALYSIS	CREDITS: 5

UNIT I: Basic Topology

Finite, Countable and Uncountable Sets – Compact Sets – Connected Sets - Continuity and Compactness – Continuity and Connectedness – Discontinuities.

Chapter 2: Titles 1,3,5; Chapter 4: 3,4,5

UNIT II: Differentiation

Differentiation - The derivative of a real function – Mean value Theorems – The continuity of the Derivative – L' Hospital's Rule – Derivatives of Higher order – Taylor's theorem – Differentiation of Vector–valued functions.

Chapter 5: Page Number: 103 - 119

UNIT III: Riemann – Stieltjes Integral

The Riemann - Stieltjes Integral – Definition and Existence of the Integral – Properties of the Integral – Integration and Differentiation – Integration of Vector–valued functions – Rectifiable curves.

Chapter 6: Page Number: 120 - 142

UNIT IV: Sequences and Series of Functions

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 – Stone Weierstrass Theorem.

Chapter 7: Page Number: 143 - 171

UNIT V: Some Special Functions

Some Special Functions – Power Series – The Exponential and Logarithmic functions – The Trigonometric functions- The algebraic completeness of the complex field – Fourier series - The Gamma function.

Chapter 8: Page Number: 172 – 203

TEXT BOOK:

Walter Rudin – Principles of Mathematical Analysis, 3rd edition, Mc Graw Hill Book Co., Kogaskusha, 1976.

Books for Supplementary Reading and Reference:

1. T.M. Apostol, Mathematical Analysis, Narosa Publ. House, New Delhi, 1985.
2. H.L. Royden, Real Analysis, Macmillan Publ. Co. Inc. 4th edition, New York, 1993.
3. V. Ganapathy Iyer, Mathematical Analysis, Tata McGraw Hill, New Delhi, 1970.

15UPMAT1C03	ORDINARY DIFFERENTIAL EQUATIONS	CREDITS: 5

UNIT I: Linear Equations with Constant Coefficients

Introduction- Second order homogeneous equations - Initial value problems - Linear dependence and independence - Formula for Wronskian.

Chapter 2: Sections 1 to 5

UNIT II: Linear Equations with Constant Coefficients (Contd.)

Non-homogeneous equations of order two - Homogeneous and non-homogeneous equations of order n - Initial value problems - Annihilator method to solve a non-homogeneous equation.

Chapter 2: Sections 6 to 8 and Sections 10 - 11

UNIT III: Linear Equations with Variable Coefficients

Initial value problems for the homogeneous equation - Solutions of the homogeneous equations - Wronskian and linear independence - Reduction of the order of a homogeneous equation.

Chapter 3: Sections 1 to 5

UNIT IV: Linear Equations with Regular Singular Points

Linear equation with regular singular points - Euler equation - Second order equations with regular singular points - Solutions and properties of Legendre and Bessels equation.

Chapter: 3 Section 8 & Chapter 4: Sections 1 to 5

UNIT V: Existence and Uniqueness of Solutions of First Order Equations

Introduction - Equations with variables separated - Exact equations - Method of successive approximations – Lipschitz condition- Convergence of the successive approximations.

Chapter 5: Sections 1 to 6

TEXT BOOK:

E.A. Codington, An Introduction to Ordinary Differential Equations, Prentice Hall of India, New Delhi, 2007.

Books for Supplementary Reading and Reference:

1. R.P. Agarwal and Ramesh C. Gupta, Essentials of Ordinary Differential Equation, McGraw, Hill, New York, 1991.
2. D. Somasundaram, Ordinary Differential Equations, Narosa Publ. House, Chennai - 2002.
3. D. Rai, D.P. Choudhury and H.I. Freedman, A Course in Ordinary Differential Equations, Narosa Publ. House, Chennai, 2004.

15UPMAT1C04	MECHANICS	CREDITS: 4

UNIT I: Mechanical Systems

The Mechanical system- Generalized coordinates – Constraints - Virtual work - Energy and Momentum

Chapter 1: Sections 1.1 to 1.5

UNIT II : Lagrange's Equations

Derivation of Lagrange's Equations- Examples- Integrals of the motion.

Chapter 2 : Sections 2.1 to 2.3 (Omit Section 2.4)

UNIT III: Hamilton's Equations

Hamilton's Principle - Hamilton's Equations - other Variational Principles.
Chapter 4 : Sections 4.1 to 4.3 (Omit section 4.4)

UNIT IV: Hamilton-Jacobi Theory

Hamilton Principle Function – Hamilton-Jacobi Equation - Separability
Chapter 5: Sections 5.1 to 5.3

UNIT V: Canonical Transformation

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

Chapter 6 : Sections 6.1, 6.2 and 6.3 (omit sections 6.4, 6.5 and 6.6)

TEXT BOOK:

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

Books for Supplementary Reading and Reference:

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.

15UPMAT1C05	ALGEBRA	CREDITS: 5

UNIT I: Another Counting Principle

Another Counting Principle – Sylow's Theorem.

Chapter 2: 2.11 and 2.12

UNIT II: Direct Products

Direct Products – Finite Abelian Groups – Polynomial Rings.

Chapter 2: 2.13, 2.14 and Chapter 3: 3.9

UNIT III: Modules

Polynomials over Rational Fields – Extension Fields – Roots of Polynomials.

Chapter 3: 3.10 ; Chapter 5: 5.1 and 5.3

UNIT IV: Galois Theory

More about Roots – Elements of Galois Theory.

Chapter 5: 5.5 and 5.6

UNIT V: Finite Fields

Solvable groups – Solvability by Radicals - Finite Fields.

Chapter 5: 5.7
Chapter 7: 7.1

TEXT BOOK:

I.N. Herstein, Topics in Algebra, 2nd edition, John Wiley and Sons, New York, 1975.

Books for Supplementary Reading and Reference:

1. S. Lang, Algebra, 3rd Edition, Addison-Wesley, Mass, 1993.
2. John B. Fraleigh, A First Course in Abstract Algebra, Addison Wesley, Mass, 1982.
3. M. Artin, Algebra, Prentice-Hall of India, New Delhi, 1991.
4. KannaBambrie, Algebra.

15UPMAT1C06	ADVANCED REAL ANALYSIS	CREDITS: 5

UNIT I:

Double sequences, double series, rearrangement of double series, a sufficient condition for equality of iterated series, multiplication of series, Casaro summability, infinite products, Euler's product for the Riemann Zeta function.

(Section 8.20 – 8.27 of [1])

UNIT II:

Linear transformations, Differentiation, the contraction principle, the inverse function theorem, the implicit function theorem.

(Chapter 9 of [2])

UNIT III:

The Rank theorem, determinants, derivatives of higher order, differentiation of integrals.

(Chapter 9 of [2])

UNIT IV:

Integration, primitive mappings, partitions of unity, change variable, differential forms.

(Chapter 10 of [2])

UNIT V:

Simplexes and chains, Stoke's theorem, closed forms and exact forms, vector analysis.

(Chapter 10 of [2])

TEXT BOOK:

1. **T.M. Apostol** – Mathematical Analysis, 2nd edition, Narosa Publ. House, New Delhi, 1985.
2. **Walter Rudin** – Principles of Mathematical Analysis, 3rd edition, MC Graw Hill Book Co., Kogaskusha, 1976.

Books for Supplementary Reading and Reference:

1. H.L. Royden, Real Analysis, Macmillan Publ. Co. INC., 4th edition, New York, 1993.
2. V. Ganapathy Iyer, Mathematical Analysis, Tata MC Graw Hill, New Delhi, 1970.

15UPMAT1C07	PARTIAL DIFFERENTIAL EQUATIONS	CREDITS: 5

UNIT I:

Nonlinear Partial Differential Equations of the first order – Cauchy's method of characteristics – Compatible systems of first order equations – Charpit's method- Special types of First order equations – Jacobi's method.

UNIT II:

Partial Differential Equations of Second order – The origin of Second-order Equations – Linear Partial Differential Equations with constant coefficients – Equations with variable coefficients – Characteristics curves of second –order equations- Characteristics of equations in three variables.

UNIT III:

The Solution of Linear Hyperbolic Equations – Separation of variables – The Method of Integral Transforms – Nonlinear Equations of the second order.

UNIT IV:

Laplace's Equation – The occurrence of Laplace's Equation in Physics- Elementary solution of Laplace's Equation – Families of Equipotential surfaces Boundary value problems – Separation of variables- Problems with axial symmetry.

UNIT V:

The wave equation – The occurrence of wave equation in Physics – Elementary solutions of the one-dimensional wave equation – Vibrating Membranes: Applications of the calculus of variations – Three dimensional problems.

The Diffusion Equations: Elementary solutions of the Diffusion Equation – Separation of variables- The use of Integral transforms.

TEXT BOOK:

I. N. Sneddon, Elements of Partial Differential Equations, International Edition, McGraw-Hill, Singapore, 1957.

UNIT I:	Chapter 2: Section 7,8,9,10,11 and 13
UNIT II:	Chapter 3: Section 1,4, 5, 6 and 7
UNIT III:	Chapter 3: Sections 8,9,10 and 11
UNIT IV:	Chapter 4: Sections 1,2,3,4,5 and 6
UNIT V:	Chapter 5: Sections: 1,2,4 and 5
	Chapter 6: Sections 3,4 and 5

Books for Supplementary Reading and Reference:

1. K. Sankara Rao, Introduction to Partial Differential Equations, Second Edition, Prentice – Hall of India, New Delhi - 2006.
2. J.N. Sharma and K. Singh, Partial Differential Equation for Engineers and Scientists, Narosa Publ. House, Chennai 2001.

15UPMAT1C08	TOPOLOGY	CREDITS: 5

UNIT I: Topological Spaces

Topological spaces – Basis for a topology – The order topology – The product topology on $X \times Y$ – The subspace topology – Closed sets and limit points.

Chapter 2, Sections 12 to 17

UNIT II: Continuous Functions

Continuous functions – The product topology – The metric topology.

Chapter 2 : Sections 18 to 21

UNIT III: Connectedness

Connected spaces- connected subspaces of the real line – Components and local connectedness.

Chapter 3 : Sections 23 to 25

UNIT IV: Compactness

Compact spaces – compact subspaces of the Real line – Limit Point Compactness – Local Compactness.

Chapter 3: Sections 26 to 29

UNIT V: Countability and Separation Axioms

The Countability Axioms – The separation Axioms – Normal spaces – The Urysohn Lemma – The Urysohn metrization Theorem - The Tietz extension theorem.

Chapter 4: Sections 30 to 34

TEXT BOOK:

James R. Munkres, Topology, 2nd Edition, Prentice Hall of India Pvt. Ltd., 2000, (Third Indian Reprint)

Books for Supplementary Reading and Reference:

1. J. Dugundji , "Topology" , Prentice Hall of India, New Delhi, 1975.
2. George F.Sinmons,"Introduction to Topology and Modern Analysis", McGraw Hill Book Co., 1963.
3. J.L. Kelly, "General Topology", Van Nostrand, Reinhold Co., New York

15UPMAT1C09	COMPLEX ANALYSIS	CREDITS: 5

Unit I: Complex Functions

Spherical representation of complex numbers - Analytic functions - Limits and continuity - Analytic Functions - Polynomials - Rational functions - Elementary Theory of Power series - Sequences - Series - Uniform Convergence - Power series - Abel's limit functions - Exponential and Trigonometric functions - Periodicity - The Logarithm.

Chapter 1: Section 2.4, Chapter 2: Sections 1 to 3

Unit II: Analytical functions as mappings

Analytical Functions as Mappings - Conformality - Arcs and closed curves - Analytic functions in Regions - Conformal mapping - Length and area - Linear transformations - Linear group - Cross ratio - symmetry - Oriented Circles - Families of circles - Elementary conformal mappings - Use of level curves - Survey of Elementary mappings - Elementary Riemann surfaces.

Chapter 3: Sections 2 to 4

Unit III: Complex Integration

Complex Integration - Fundamental Theorems - Line Integrals – Rectifiable Arcs- Line Integrals as Arcs- Cauchy's Theorem for a rectangle and in a disk- Cauchy's Integral Formula – Index of point with respect to a closed curve – The Integral formula – Higher order derivatives – Local properties of analytic functions – Taylor's Theorem – Zeros and Poles – Local mapping – Maximum Principle.

Chapter 4: Sections 1 to 3

Unit IV: Complex Integration (Contd.)

The General form of Cauchy's Theorem - Chains and Cycles – Simple connectivity – Homology – General statement of Cauchy's theorem – Proof of Cauchy's theorem – Locally exact differentials - Multiply connected regions – Calculus of residues – Residue Theorem – Argument Principle – Evaluation of definite Integrals

Chapter 4 : Sections 4 and 5

Unit V: Harmonic functions and Power Series expansions

Harmonic Functions – Definition and basic properties – Mean-value Property - Poisson's formula – Schwarz's Theorem – Reflection Principle – Weierstrass's theorem – Taylor's series- Laurent series

Chapter 4: Section 6 and Chapter 5: Section 1

TEXT BOOK:

L.V. Ahlfors, Complex Analysis, 3rd edition, Mc Graw Hill Inter., Edition, New Delhi ,1979.

Books for Supplementary Reading and Reference:

1. J.B. Conway, Functions of One Complex Variable, Narosa Publication House, New Delhi, 1980.
2. S. Ponnusamy, Foundations of Complex Analysis, Narosa Publication House, New Delhi, 2004.
3. S. Lang, Complex Analysis, Addison - Wesley Mass, 1977.

15UPMAT1C10	GRAPH THEORY	CREDITS: 4

UNIT I:

Graphs, Subgraphs and Trees: Graphs and simple graphs – Graph Isomorphism - Incidence and Adjacency Matrices - Subgraphs – Vertex Degrees - Paths and Connection - Cycles - Trees - Cut Edges and Bonds - Cut Vertices – Cayley's formula.

Chapter 1: Sections 1.1 to 1.7, Chapter 2: Section 2.1 to 2.4

UNIT II:

Connectivity, Euler tours and Hamilton Cycles: Connectivity - Blocks - Euler tours – Hamilton Cycles.

Chapter 3: Sections 3.1 to 3.2, Chapter 4: Sections 4.1 to 4.2

UNIT III:

Matchings, Edge Colourings: Matchings - Matchings and Coverings in Bipartite Graphs – Perfect Matching- Edge Chromatic Number - Vizing's Theorem.

Chapter 5: Sections 5.1 to 5.3, Chapter 6: Sections 6.1 to 6.2

UNIT IV:

Independent sets and Cliques, Vertex Colourings: Independent sets - Ramsey's Theorem - Chromatic Number - Brooks' Theorem – Chromatic Polynomials.

Chapter 7: Sections 7.1 to 7.2, Chapter 8: Sections 8.1 to 8.2, 8.4

UNIT V:

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

Chapter 9: Sections 9.1 to 9.3, 9.6

TEXT BOOK:

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

Books for Supplementary Reading and Reference:

1. J.Clark and D.A.Holton, A First look at Graph Theory, Allied Publishers, New Delhi, 1995.
2. R.J..Wilson. and J.J.Watkins, Graphs: An Introductory Approach, John Wiley and Sons, New York, 1989.
3. S.A.Choudum, A First Course in Graph Theory, MacMillan India Ltd. 1987.
4. R. Balakrishnan and K. Ranganathan, A Textbook of Graph Theory, Springer Verlag, New York, 1999.

15UPMAT1C11	PROBABILITY THEORY	CREDITS: 4

UNIT I:

Random Events and Random Variables - Random events – Probability axioms – Combinatorial formulae – conditional probability – Bayes Theorem – Independent events – Random Variables – Distribution Function – Joint Distribution – Marginal Distribution – Conditional Distribution – Independent random variables – Functions of random variables.

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

UNIT II:

Parameters of the Distribution - Expectation- Moments – The Chebyshev Inequality – Absolute moments – Order parameters – Moments of random vectors – Regression of the first and second types.

Chapter 3: Sections 3.1 to 3.8

UNIT III:

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 – Probability generating functions.

Chapter 4: Sections 4.1 to 4.7

UNIT IV

Some probability distributions - One point , two point , Binomial – Polya – Hypergeometric – Poisson (discrete) distributions – Uniform – normal gamma – Beta – Cauchy and Laplace (continuous) distributions.

Chapter 5: Section 5.1 to 5.10 (Omit Section 5.11)

UNIT V

Limit Theorems - 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 – Lyapunov Theroem – Borel-Cantelli Lemma - Kolmogorov Inequality and Kolmogorov Strong Law of large numbers.

Chapter 6: Sections 6.1 to 6.4, 6.6 to 6.9, 6.11 and 6.12.
(*Omit Sections 6.5, 6.10, 6.13 to 6.15*)

TEXT BOOK:

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

Books for Supplementary Reading and Reference:

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.

15UPMAT1C12	MEASURE THEORY AND INTEGRATION	CREDITS: 5

UNIT I: Lebesgue Measure

Lebesgue Measure - Introduction – Outer measure - Measurable sets and Lebesgue measure- Measurable functions - Littlewoods' Three Principles.

Chapter 3: Sections 1 to 3, 5 and 6

UNIT II: Lebesgue integral

Lebesgue Integral - The Riemann integral - Lebesgue integral of bounded functions over a set of finite measure - The integral of a nonnegative function - The general Lebesgue integral.

Chapter 4: Sections 1 to 4

UNIT III: Differentiation and Integration

Differentiation and Integration - Differentiation of monotone functions - Functions of bounded variation - Differentiation of an integral - Absolute continuity.

Chapter 5 : Sections 1 to 4

UNIT IV: General Measure and Integration

General Measure and Integration - Measure spaces - Measurable functions - integration - General convergence theorem- Signed Measure - The Radon - Nikodym theorem.

Chapter 11: Sections 1 to 3, 5 and 6

UNIT V: Measure and Outer Measure

Measure and outer measure - outer measure and measurability - The Extension theorem - Product measures.

Chapter 12: Sections 1,2 and 4

TEXT BOOK:

H.L. Royden, Real Analysis, Mc Millan Publ. Co. New York 1993.

Books for Supplementary Reading and Reference:

1. G. De Barra, Measure Theory and Integration, Wiley Eastern Ltd., 1981.
2. P.K. Jain and V.P. Gupta, Lebesgue Measure and Integration, New Age Int. (P) Ltd., NewDelhi, 2000.
3. Walter Rudin, Real and Complex Analysis, Tata McGraw Hill Publ. Co. Ltd., New Delhi, 1966.

15UPMAT1C13	FUNCTIONAL ANALYSIS	CREDITS: 5

UNIT I: Banach Spaces

Definition and some examples – Continuous linear transformations – The Hahn-Banach theorem.

Chapter 9 : Sections: 46 to 48

UNIT II: Banach spaces and Hilbert spaces

The natural imbedding of N in N** - Open mapping theorem – conjugate of an operator – Definition and some simple properties.

Chapter 9 : Sections: 49 to 51 and Chapter 10 : Section: 52

UNIT III: Hilbert Spaces

Orthogonal complements – orthonormal sets - Conjugate space H* - Adjoint of an operator.

Chapter 10: Sections: 53 to 56

UNIT IV: Operation on Hilbert spaces

Self-adjoint operators – Normal and unitary operators – Projections.

Chapter 10: Sections: 57 to 59

UNIT V: General Preliminaries on Banach Algebras

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

Chapter 12 : Sections: 64 to 69

TEXT BOOK:

G.F.Simmons , Introduction to topology and Modern Analysis, Tata McGraw -Hill Publishing Company, New Delhi, 2004.

Books for Supplementary Reading and Reference:

1. W. Rudin Functional Analysis, Tata McGraw-Hill Publishing Company, New Delhi , 1973.
2. G. Bachman & L.Narici, Functional Analysis Academic Press, New York ,1966.
3. H.C. Goffman and G.Fedrick, First course in functional Analysis, Prentice Hall of India, New Delhi, 1987

15UPMAT1E01	DISCRETE MATHEMATICS	CREDITS: 4

UNIT I:

Logic – Propositional equivalence – Predicates and quantifiers – the growth of functions.

UNIT II:

Counting: Basics of counting – The pigeonhole principle – permutations and combinations – Generalized permutations and combinations – Generating permutations and combinations.

UNIT III:

Advanced counting techniques: recurrence relation – solving recurrence relations – Generating functions.

UNIT IV:

Boolean Algebra: Boolean functions – Representing Boolean functions – Logic Gates – Minimization of circuits.

UNIT V:

Modeling Computations: finite – state machines with output, finite – state machines with no output – Turing machines

TEXT BOOK:

Kenneth H. Rosen, Discrete Mathematics and its Applications (fourth edition), WCB/ McGraw Hill Publications,

Sections: 1.1, 1.2, 1.3, 1.8, 4.1 to 4.3, 4.6, 4.7, 5.1, 5.2, 5.4, 9.1 to 9.4, 10.2, 10.3, 10.5.

Books for Supplementary Reading and Reference:

1. J.P. Tremblay and R. Manohar, Discrete Mathematical Structures with Applications to Computer Science, Tata McGraw Hill Publishing Company Limited, 35th Reprint 2008.
2. T. Veerarajan, Discrete Mathematics with Graph Theory and Combinatorics, Tata McGraw Hill Publishing Company Limited, 7th Reprint, 2008.

15UPMAT1E02	HARMONIC ANALYSIS	CREDITS: 4

UNIT I:

Definition of Fourier Series and easy results - the Fourier Transform, Convolution - Approximate Identities - Fejer's Theorem - Unicity Theorem - Parseval's Relation - Fourier Steiltje's Coefficients.

Chapter 1: Sections: 1.1 - 1.4

UNIT II:

The Classical Kernels – Summability - Metric Theorems - Pointwise Summability - Positive Definite Sequences - Herglotz's Theorem

Chapter 1: Sections: 1.5 - 1.8

UNIT III:

The Inequality of Hausdorff and Young - Measures with bounded powers - Endomorphisms of l' - the Fourier Integral- Introduction - Kernels on R.

Chapter 1: Sections: 1.9 - 1.10, Chapter 2: Sections: 2.1 - 2.2.

UNIT IV:

The Plancherel Theorem - Another Convergence Theorem - the Poisson Summation Formula - Bockner's Theorem - The Continuity Theorem.

Chapter 2: Sections: 2.3 - 2.6.

UNIT V:

Characters of Discrete Groups - Characters of Compact Groups - Bockner's Theorem, Examples - Minkowski's Theorem.

Chapter 3: Sections: 3.1 - 3.5.

TEXT BOOK:

Henry Helson, "Harmonic Analysis", 2nd edition, Hindustan Book Agency, New Delhi, 1995.

Books for Supplementary Reading and Reference:

1. W.Rudin, "Real and Complex Analysis", 3rd edition, McGraw Hill International Editions, New York, 1987.
2. W.Rudin, "Fourier Analysis on Groups", Interscience Publishers, New York, 1985.
3. Rajendra Bhatia, "Fourier Series", 2nd edition, Hindustan Book Agency, New Delhi, 2003.

15UPMAT1E03	DIFFERENCE EQUATIONS	CREDITS: 4

UNIT I: Difference Calculus

Difference operator - Summation – Generating function and Approximate Summation.

Chapter 2: Sections 2.1 to 2.3

UNIT II: Linear Difference Equations

First order equations - General results for linear equations - Solving Linear Equations.

Chapter 3: Sections 3.1 to 3.3

UNIT III: Linear Difference Equations (Contd.)

Equations with Variable Coefficients – The z -Transform.

Chapter 3: Sections 3.5 and 3.7

UNIT IV: Stability Theory

Initial value problems for linear systems – Stability of linear systems.

Chapter 4: Sections 4.1 and 4.2

UNIT V: Asymptotic Methods

Introduction- Asymptotic analysis of sums - Linear equations.

Chapter 5: Sections 5.1 to 5.3

TEXT BOOK:

W.G. Kelley and **A.C. Peterson,** Difference Equations,2nd edition Academic Press, New York, 1991.

Books for Supplementary Reading and Reference:

1. S.N. Elaydi, An Introduction to Difference Equations, Springer - Verlag, NewYork, 1995.
2. R. Mickens, Difference Equations, Van Nostrand Reinhold, New York, 1990.
3. R.P. Agarwal, Difference Equations and Inequalities, Marcel Dekker, New York, 1992.

15UPMAT1E04	NUMERICAL ANALYSIS	CREDITS: 4

UNIT I: Solution of Nonlinear Equations

Newton's method – Convergence of Newton's method – Bairstow"s Method for quadratic factors. NUMERICAL DIFFERENTIATION AND INTEGRATION: Derivatives from Differences tables – Higher order derivatives – Divided difference, Central-Difference formulas – Composite formula of Trapezoidal rule – Romberg integration – Simpson's rules.

UNIT II: Solution of System of Equations

The Elimination method – Gauss and Gauss Jordan methods – LU Decomposition method – Matrix inversion by Gauss-Jordan method – Methods of Iteration – Jacobi and Gauss Seidal Iteration – Relaxation method – Systems of Nonlinear equations.

UNIT III: Solution of Ordinary Differential Equations

Taylor series method – Euler and Modified Euler methods – Rungekutta methods – Multistep methods – Milne's method – Adams Moulton method.

UNIT IV: Boundary Value Problems and Characteristic Value Problems

The shooting method – solution through a set of equations – Derivative boundary conditions – Characteristic value problems – Eigen values of a matrix by Iteration – The power method.

UNIT V: Numerical Solution of Partial Differential Equations

Solutions of Elliptic, Parabolic and Hyperbolic partial differential equations) Representation as a difference equation – Laplace's equation on a rectangular region – Iterative methods for Laplace equation – The Poisson equation – Derivative boundary conditions – Solving the equation for time-dependent heat flow (i) The Explicit method (ii) The Crank Nicolson method
-solving the wave equation by Finite Differences.

TEXT BOOK:

C.F.Gerald and **P.O.Wheatley**, Applied Numerical Analysis, Fifth Edition, Addison Wesley, (1998).

Books for Supplementary Reading and Reference:

1. M.K. Venkatraman, Numerical Methods in Science and Technology, National Publishers Company, 2nd Edition, (1992).
2. S.C. Chapra and P.C. Raymond: Numerical Methods for Engineers, Tata McGraw Hill, New Delhi, (2000).
3. P. Kandasamy et al.: Numerical Methods, S. Chand & Company Ltd., New Delhi (2003).

15UPMAT1E05	METHODS OF APPLIED MATHEMATICS	CREDITS: 4

UNIT I: Calculus of Variations

Calculus of Variations – Maxima and Minima – Simplest case – Natural and transition boundary conditions – variational notation – general case – Constraints and Lagranges multipliers – variable end points – Sturm Liouvile problems.

UNIT II: Applications of Calculus of Variations

Hamiltons's principle – Lagranges equation – generalized dynamic entites – constraints in dynamical systems – small vibrations about equilibrium – variational problems for deformable bodies – Rayleih – Ritz method.

UNIT III: Integral Equations

Integral equations – Relations between differential and integral equations – Green function – Fredholm equations with separable kernels.

UNIT IV: Integral Equations (contd.)

Hilbert – Schmidt theory – Litrative method for solving equations of the second kind. Neumann Series – Fredholm theory – Singular integral equations.

UNIT V: Special devices

Special devices – Relative approximation to characteristic functions. Approximation of Fredholm equations by sets of algebraic equilibrium.

TEXT BOOK:

F.B. Hildebrand, Methods of Applied Mathematics, Prentice-Hall of India Pvt. New Delhi, 1968.

Books for Supplementary Reading and Reference:

1. R.P. Kanwal, Linear integral equation, Theory and Techniques, Acad. Press, 1971.
2. A.S. Gupta, Calculus of Variations with Application, Prentice-Hall of India, New Delhi, 2005
3. L. Elsgolts, Differential Equations and Calculus of Variations, Mir Publishers, Moscow, 1973.

15UPMAT1E06	OPTIMIZATION TECHNIQUES	CREDITS: 4

UNIT I: Linear Programming Proplems.

Dual Simplex – Revised Simplex - Illustrative Applications - Integer Programming Algorithms

Chapter: 4: Section 4.4., Chapter 7: Section 7.2 and Chapter 9: Section 9.1 and 9.2

UNIT II: Decision Analysis and Games

Decision Making under Certainty – Decision Making under Risk – Decision under uncertainty – Game Theory.

Chapter 14: Sec. 14.1 to 14.4

UNIT III: Inventory Models - Deterministic Models

Inventory Models - Probabilistic Models

Chapter 11: Sec. 11.1 to 11.3 and Chapter 16: Sec. 16.1.

UNIT IV: Queuing Theory

Elements of a Queuing model – Role of Exponential Distribution – Pure Birth and Death Models – Generalized Poisson Queuing Model – Specialized Poisson Queues – (M/G/1): (GD/∞/∞) – Pollaczek - Khintchine (P-K) Formula.

Chapter 17: Sec.17.2 to 17.7 (Omit Section: 17.6.4)

UNIT V: Optimization Theory

Classical Optimization Theory – Unconstrained Problems – Constrained Problems.

Chapter 20: Sections. 20.1 and 20.2

TEXT BOOK

Hamdy A Taha, Operations Research – An Introduction, Seventh Edition, Prentice – Hall of India, New Delhi, 2003.

Books for Supplementary Reading and Reference:

1. F.S.Hillier and G.J.Lieberman, Introduction to Operations Research (IV Edition), Mc Graw Hill Book Company, New York, 1989.
2. Philips D.T., Ravindra A. and Solberg J., Operations Research, Principles and Practice, John Wiley and Sons, New York, 1991.
3. B.E.Gillett, Operations Research – A Computer Oriented Algorithmic Approach, TMH Edition, New Delhi, 1976.

15UPMAT1E07	COMBINATORIAL MATHEMATICS	CREDITS: 4

UNIT I:

Permutations and combinations.

UNIT II:

Generating functions.

UNIT III:

Recurrence relations.

UNIT IV:

Principle of inclusion and exclusion.

UNIT V:

Polya's theory of counting.

TEXT BOOK

C.L.Liu, Introduction to Combinatorial Mathematics, Tata McGraw Hill,

Chapters 1 to 5.

Books for Supplementary Reading and Reference:

1. C.L. Liu, M. Eddberg, Solutions to problems in Introducyion to Combinatorial mathematics, MC Grow-Hill Book & Co., New York, 1968.
2. J.H. Van Lint, R.M. Wilson, A Course in Combinatorics, 2nd Edition, Cambridge University Press, Cambridge, 2001.
3. R.P. Stanley, Enumerative Combinatorics, Volume I, Cambridge Studies in Advanced Mathematics, Volume 49, Cambridge University Press, 1997.
4. P.J. Cameron, Combinatorics: Topics, Techniques, Algorithms, Cambridge University Press, Cambridge, 1998.

15UPMAT1E08	FUZZY SETS AND THEIR APPLICATIONS	CREDITS: 4

UNIT I: Fuzzy sets

Fuzzy sets – Basic types – basic concepts – Characteristics- Significance of the paradigm shift - Additional properties of α – cuts.

Chapter 1: Sections 1.3 to 1.5 and Chapter 2: Section 2.1

UNIT II: Fuzzy sets versus CRISP Sets

Representation of Fuzzy sets- Extension principle of Fuzzy sets – Operation on Fuzzy Sets – Types of operation – Fuzzy complements

Chapter 2: Sections 2.2 and 2.3 and Chapter 3: Sections 3.1 and 3.2

UNIT III: Operations on Fuzzy sets

Fuzzy intersection – t-norms , Fuzzy unions – t conorms-Combinations of operations – Aggregation operations

Chapter 3: Sections 3.3 to 3.6

UNIT IV: Fuzzy Arithmetic

Fuzzy numbers – Linguistic variables – Arithmetic operation on intervals – Lattice of Fuzzy numbers.

Chapter 4: Sections 4.1 to 4.4

UNIT V: Constructing Fuzzy Sets

Methods of construction: an overview – direct methods with one expert – direct method with multiple experts – indirect method with multiple experts and one expert- Construction from sample data

Chapter 10: Sections 10.1 to10.7

TEXT BOOK:

G.J. Klir and Bo Yuan, Fuzzy Sets and Fuzzy Logic: Theory and Applications, Prentice Hall of India Ltd, New Delhi, 2005.

Books for Supplementary Reading and Reference:

1. H.J.Zimmermann, Fuzzy Set Theory and its Applications, Allied Publishers, Chennai, 1996.
2. A.Kaufman, Introduction to the Theory of Fuzzy Subsets, Academi Press, New York, 1975.
3. V.Novak, Fuzzy Sets and Their Applications, Adam Hilger, Bristol, 1969.

15UPMAT1E09	REPRESENTATION THEORY	CREDITS: 4

UNIT I: Group representations

Group representations – FG modules - FG-submodules and reducibility- group algebras.

UNIT II: Group algebra

FG- homomorphisms- Maschke's Theorem- Schur's Lemma- Irreducible modules and the group algebra.

UNIT III: More on the group Algebra

More on the group algebra- conjugacy classes- characters.

UNIT IV: Irreducible characters

Inner product of characters- the number of irreducible characters.

UNIT V: Character tables

Character tables and orthogonality relations- normal subgroups and lifted characters- some elementary character tables.

TEXT BOOK:

G.James and M.Liebeck, Representations and Characters of Groups, 2nd edition, Cambridge University Press, London, 2001.

Books for Supplementary Reading and Reference:

1. C.W. Curtis and I.Reiner, Methods of Representation Theory with Applications to Finite Groups and Orders, Volume 1, Wiley – Interscience, New York, 1981.
2. J.P. Serre, Linear Representation of Finite Groups, Springer-Verlag, New York, 1977.
3. W. Fulton and J.Harris, Representation Theory – A First Course, Graduate Texts in Mathematics 129, Springer – Verlag, New York, 1991.

15UPMAT1E10	CALCULUS OF VARIATIONS AND INTEGRAL EQUATIONS	CREDITS: 4

UNIT I: Variational problems with fixed boundaries

The concept of Variation and its properties - Euler's equation - Variational problems for Functionals - Functionals dependent on higher order derivatives - Functions of several independent variables - Some applications to problems of Mechanics.

Chapter 1: Sections 1.1 to 1.7

UNIT II: Variational problems with moving boundaries

Movable boundary for a functional dependent on two functions - One-sided variations - Reflection and Refraction of extremals - Diffraction of light rays.

Chapter 2: Sections 2.1 to 2.5

UNIT III: Integral Equation

Introduction - Types of Kernels - Eigen values and Eigen function - connection with differential equation - Solution of an integral equation - Initial value problems - Boundary value problems.

Chapter 1: Sections 1.1 to 1.3 and 1.5 to 1.8

UNIT IV: Solution of Fredholm integral equation

Second kind with separable kernel - Orthogonality and reality eigen function - Fredholm Integral equation with separable kernel - Solution of Fredholm Integral Equation by successive substitution - Successive approximation - Volterra integral equation- Solution by successive substitution.

Chapter 2: Sections 2.1 to 2.3 and Chapter 4: Sections 4.1 to 4.5

UNIT V: Hilbert - Schmidt Theory

Complex Hilbert space - Orthogonal system of functions - Gram–Schmit orthogonalization process - Hilbert-Schmidt theorems – Solutions of Fredholm integral equation of first kind.

Chapter 3: Sections 3.1 to 3.4 and 3.8 to 3.9

TEXT BOOK:

1. **A.S. Gupta,** Calculus of Variations with Application, Prentice Hall of India, New Delhi, 2005.
2. **Sudir K. Pundir and Rimple Pundir,** Integral Equations and Boundary Value Problems,Pragati Prakasam, Meerut, 2005.

Books for Supplementary Reading and Reference:

1. F.B. Hildebrand, Methods of Applied Mathematics, Prentice - Hall of India Pvt. New Delhi, 1968.
2. R.P. Kanwal, Linear Integral Equations, Theory and Techniques, Academic Press, New York, 1971.
3. L. Elsgolts, Differential Equations and Calculus of Variations, Mir Publishers, Moscow, 1973.

15UPMAT1E11	COMPUTER PROGRAMMING LAB	CREDITS: 4

Classes and Objects – Constructors and Destructors – Inheritance (single, multiple, hybrid, hierarchical) – Polymorphism (function overloading, function overriding and operator overloading) – Templates – Exception Handling.

LIST OF PRACTICALS

1. Solving a quadratic equation for all types of roots
2. Obtaining the root of an equation by bisection method
3. Obtaining the root of an equation by False – position method
4. Obtaining the root of a transcendental equation by Newton – Raphson method
5. Determining the Eigenvalues & Eigenvectors of a symmetric matrix.
6. Programming for polynomial Interpolation
7. Single Integration by Trapezoidal rule.
8. Single Integration by Simpson's 1/3 rule.
9. Solving ODE using second order Runge-Kutta Method.
10. Solving ODE using fourth order Runge-Kutta Method.
11. Solving ODE using Taylor's Series Method.
12. Solving ODE using Euler's Method.
13. Solving set of simultaneous linear equations by Jacobi Iteration Method.
14. Solving set of simultaneous linear equations by Gauss elimination Method.
15. Solving set of simultaneous linear equations by Gauss Seidal Iteration Method

One question may be asked from the above list.

TEXT BOOK:

E. Balagurusamy, Programming in ANSI C, 2nd Edition, Tata Mc Graw Hill (1992).

Books for Supplementary Reading and Reference:

1. V. Rajaraman, Computer Programming in C, Eastern Economy Edition, Second Printing (1995).
2. E. Balagurusamy, Programming in ANSI C, 2nd Edition, Twentieth Reprint, Tata Mc Graw Hill Publishing Co., Ltd., New Delhi (1998).
3. C.Xavier, C Language and Numerical Methods, New Age International (P) Limited, Publishers, New Delhi, (1999).

15UPMAT1E12	NON COMMUTATIVE ALGEBRA	CREDITS: 4

UNIT I: Decompositions of Rings:

Modules and homorphisms – Classical isomorphism theorems – direct sums and products – free modules – two sided Peirce decomposition of a ring – the Wedderburn – Artin theorem – finitely decomposable rings.

Chapter 1 and Chapter 2

UNIT II: Artinian and Notherian Rings:

The Jordan-Holder theorem – the Hilbert basis theorem – the radical of a module and a ring – the radical of an Artinian rings – Semiprimary rings.

Chapter 3

UNIT III: Categories and Functors:

Exact sequences – direct sums and direct products – the Hom functors – tensor product functor – direct and inverse limits.

Chapter 4

UNIT IV: Projectives, Injectives and Flats:

Projective modules – injective modules – essential extensions and injective hulls – flat modules – right hereditary and right semihereditary rings – Herstein-Small rings.

Chapter 5

UNIT V: Homological Dimensions:

Complexes and homology, free solutions – Projective and Injective resolutions, Derived functors – the functors Tor, EXT__ , projective and injective dimensions – global dimensions.

Chapter 6

TEXT BOOK:

M. Hazewinkel, N. Gubareni and **V.V. Kirichenko,** Algebras, Rings and Modules, Volume I, Springer International Edition, New Delhi, 2011.

Books for Supplementary Reading and Reference:

1. I.N. Herstein, Non Commutative Rings, Carus Mathematicalmonographs No.15, Mathematical Association of America, 1962.
2. H. Cartan and S. Eilenberg, Homological Algebra, Princeton University Press, Princeton, New York, 1956.
3. L.R. Vermani, An Elemantary Apprroach to Homological Algebra, Chapman & Hall / CRC Monographs and Survays in Pure and Applied Mathematics. Vol. 130, CRS Press, LLC, Florida, 2003.
4. T.Y. Lam, Lectures on Modules and Rings, Graduate Texts in Mathematics, Vol. 189, Springer-Verlag, Berlin-Heidelberg, New York, 1999.

15UPMAT1E13	COMMUTATIVE ALGEBRA	CREDITS: 4

Unit I: Module Homomorphisms

Rings and ring homomorphisms – ideals – Extension and Contraction, modules and module homomorphism – exact sequences.

Pages: 01 - 24

Unit II: Tensor Product of Modules

Tensor product of modules – Tensor product of algebra – Local properties – extended and contracted ideals in rings of fractions.

Pages: 24 - 49

Unit III: Primary Decomposition

Primary Decomposition – Integral dependence – The going-up theorem – The going-down theorem – Valuation rings.

Pages: 50 - 73

Unit IV: Noetherian Rings

Chain conditions – Primary decomposition in Noetherian rings.

Pages: 74 – 88

Unit V: Artin Rings

Artin rings – Discrete valuation rings – Dedekind domains – Fractional ideals.

Pages: 89 – 99

TEXT BOOK

Introduction to Commutative Algebra, by **M.F.Atiyah** and **I.G.Macdonald**, Addison – Wesley Publication Company, Inc, 1969.

Books for Supplementary Reading and Reference:

1. N.S. Gopalakrishnan, Commutative Algebra, Oxonian Press Pvt. Ltd, New Delhi, 1988
2. F.W. Andeson and K.R. Fuller, Rings and Categories of Modules, 2nd Edition, Graduate Text in Mathematics Vol. 13, Springer-Verlag, New York, 1992
3. H. Matsumura, Commutative ring theory, Cambridge University Press, 1986.

15UPMAT1E14	CONTROL THEORY	CREDITS: 4

Unit-I: Observability

Linear Systems – Observability Grammian – Constant coefficient systems – Reconstruction kernel – Nonlinear Systems.

Chapter 2.

Unit-II: Controllability

Linear systems – Controllability Grammian – Adjoint systems – Constant coefficient systems – Steering function – Nonlinear systems.

Chapter 3: Sections 3.1-3.3

Unit-III: Stability

Stability – Uniform stability – Asymptotic stability of linear systems - Linear time varying systems – Perturbed linear systems – Nonlinear systems.

Chapter 4

Unit-IV: Stabilizability

Stabilization via linear feedback control – Bass method – Controllable subspace – Stabilization with restricted feedback.

Chapter 5.

Unit-V: Optimal Control

Linear time varying systems with quadratic performance criteria – Matrix Riccati equation – Linear time invariant systems – Nonlinear Systems.

Chapter 6.

TEXT BOOK

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

Books for Supplementary Reading and Reference:

1. R.Conti, *Linear Differential Equations and Control,* Academic Press, London, 1976.
2. R.F.Curtain and A.J.Pritchard, *Functional Analysis and Modern Applied Mathematics,* Academic Press, New York, 1977.
3. J.Klamka, *Controllability of Dynamical Systems,* Kluwer Academic Publisher, Dordrecht, 1991.
4. J.Klamka, *Controllability of Dynamical Systems,* Kluwer Academic Publisher, Dordrecht, 1991.

15UPMAT1E15	STOCHASTIC DIFFERENTIAL EQUATIONS	CREDITS: 4

Unit I: Mathematical Preliminaries and Itô Integrals

Probability Spaces – Random variables and Stochastic Processes – An Important Example: Brownian motion – Construction of the Itô Integral – Some Properties of the Itô Integral – Extensions of the Itô Integral.

Chapter 2: Sections : 2.1-2.2 and Chapter 3: Sections : 3.1-3.3

Unit II: Itô Formula and Martingale Representation Theorem

The 1-dimensional Itô Formula - The Multi-dimensional Itô Formula – The Martingale Representation Theorem.

Chapter 4: Sections 4.1-4.3

Unit III: Stochastic Differential Equations

Examples and Some Solution Methods – An Existence and Uniqueness Result – Weak and Strong Solutions.

Chapter 5: Sections 5.1-5.3

Unit IV: The Filtering Problem

Introduction – The 1-Dimensional Linear Filtering Problem – The Multidimensional Linear Filtering Problem.

Chapter 6: Sections 6.1-6.3

Unit V: Diffusions: Basic Properties

The Markov Property – The Strong Markov Property – The Generator of an Itô Diffusion – The Dynkin Formula – The Characteristic Operator.

Chapter 7: Sections 7.1-7.5

TEXT BOOK:

B. Oksendal, *Stochastic Differential Equations: An Introduction with Applications,* Sixth Edition, Springer - Verlag, Heidelberg, 2003.

Books for Supplementary Reading and Reference:

1. Avner Friedman, Stochastic Differential Equations and Application, Dover Publications, 2006.
2. Ludwig Arnold, Stochastic Differential Equations: Theory and Applications, Dover Publications, 2011.
3. Hui-Hsiung Kuo, Introduction to Stochastic Integration, Springer-Verlag, 2006
4. Douglas Henderson and Peter Plaschko, Stochastic Differential Equations in Science and Engineering, World Scientific, 2006.

15UPMAT1E16	DISTRIBUTION THEORY	CREDITS: 4

Unit - I: The Schwartz-Sobolev Theory of Distribution

Some introductory definitions – Test functions – Linear functional and the Schwartz-Sobolev theory of distributions – Examples – Algebraic operations on distributions – Analytic operations on distributions – Examples.

Section: 2.1 – 2.7.

Unit - II: Distributions Defined by Divergent Integrals

Introduction – The pseudofunction H(x)/x^n, n= 1,2,3,.... – Functions with algebraic singularity of order m – Examples.

Section: 4.1 – 4.4.

Unit - III: Tempered Distributions and the Fourier Transforms

Preliminary concepts – distributions of slow growth – The Fourier transform – Examples.

Section: 6.1 – 6.4.

Unit - IV: Direct products and convolutions of Distribution

Definition of the direct product – The direct product of tempered distributions – The Fourier transform of the direct product of tempered distributions – The convolution – The role of convolution in the regularization of the distributions – Examples – The Fourier transform of the convolution.

Section: 7.1 – 7.7.

Unit - V: Applications to Ordinary and Partial Diff. Equations

Ordinary differential operators – Homogeneous differential equations – Inhomogeneous differential equations – Examples – Fundamental solutions and Green's functions – Second order differential equations with constant coefficients.

Introduction – Classical and generalized solutions – Fundamental solutions – The Laplace operator – The heat operator – The wave operator.

Section: 9.1 – 9.6, 10.1 – 10.3, 10.6, 10.7, 10.10

TEXT BOOK:

Ram P. Kanwal, Generalized functions: theory and applications, Third Edition, Birkhauser, Boston, 2004.

Books for Supplementary Reading and Reference:

1. R.S. Strichartz, *A Guide to Distribution Theory and Fourier transforms*, World Scientific, New Jersey, 2003.
2. M. Renardy and R.C. Rogers, *An Introduction to Partial Differential Equation*, Second Edition, Springer-Verlag, New York, 2008.
3. R.S. Pathak, *A Course in Distribution Theory and Applications*, Second Edition, Narosa India, 2009.

15UPMAT1E17	NUMBER THEORY	CREDITS: 4

Unit I: Divisibility and Congruences

Divisibility – Primes – Congruences – Solutions of Congruences.

Chapter 1: Sections 1.2 to 1.3 and Chapter 2: Sections: 2.1 to 2.2.

Unit II: Congruences

The Chinese Remainder Theorem – Prime Power Moduli – Prime Modulus - Primitive Roots and Power Residues – Congruences of Degree Two, Prime Modulus.

Chapter 2: Sections 2.3 and 2.6 to 2.9.

Unit III: Quadratic Reciprocity and Quadratic Forms

Quadratic Residues – Quadratic Reciprocity – The Jacobi Symbol – Sums of Two Squares.

Chapter 3: Sections 3.1 to 3.3 and 3.6.

Unit IV: Some Functions of Number Theory

Greatest Integer Function – Arithmetic Functions – The Mobius Inversion Formula - Combinatorial Number Theory.

Chapter 4: Sections 4.1 to 4.3 and 4.5.

Unit V: Some Diophantine Equations

The Equation ax + by=c – Simultaneous Linear Equations – Pythagorean Triangles – Assorted Examples.

Chapter 5: Sections 5.1 to 5.4.

TEXT BOOK:

I. Niven, H. S. Zuckerman and H. L. Montgomery, An Introduction to the Theory of Numbers, 5th edition, John Wiley & Sons, Inc., New York, 2004.

Books for Supplementary Reading and Reference:

1. D.M. Burton, Elementary Number Theory, Universal Book, Stall, New Delhi 2001.
2. K. Ireland and M. Rosen, A Classical Introduction to Modern Number Theory, Springer Verlag, New York, 1972.
3. T.M. Apostol, Introduction to Analytic Number Theory, Narosa Publ. House, Chennai, 1980.

15UPMAT1E18	DIFFERENTIAL GEOMETRY	CREDITS: 4

UNIT I: Theory of Space Curves

Introduction – Representation of space curves – Unique parametric representation of a space curve – Arc-length – Tangent and osculating plane – Principal normal and binormal – Curvature and torsion – Behaviour of a curve near one of its points – The curvature and torsion of a curve as the intersection of two surfaces.

Chapter 1: Sections 1.1 to 1.9

UNIT II: Theory of Space Curves (Contd.)

Contact between curves and surfaces – Osculating circle and Osculating sphere – Locus of centres of spherical curvature – Tangent surfaces, involutes and evolutes – Intrinsic equations of space curves – Fundamental existence theorem – Helices

Chapter 1: Sections 1.10 to 1.13 and 1.16 to 1.18.

UNIT III: Local Intrinsic Properties of a Surface

Introduction - 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 – Direction coefficients on a surface.

Chapter 2: Sections 2.1 to 2.10

UNIT IV: Local Intrinsic Properties of Surface and Geodesics on a Surface

Families of curves – Orthogonal trajectories – Double family of curves – Isometric correspondence – Intrinsic properties – Geodesics and their differential equations – Canonical geodesic equations – Geodesics on surface revolution.

Chapter 2: Sections 2.11 to 2.15 and Chapter 3: Sections 3.1 to 3.4

UNIT V: Geodesics on a Surface

Normal property of geodesics – Differential equations of geodesics using normal property – Existence theorems – Geodesic parallels – Geodesic curvature – Gauss-Bonnet theorem – Gaussain curvature – Surfaces of constant curvature.

Chapter 3: Sections 3.5 to 3.8 and Sections 3.10 to 3.13

TEXT BOOK:

D. Somasundaram, Differential Geometry, a First Course, Narosa Publishing House, Chennai, 2005.

Books for Supplementary Reading and Reference:

1. T.Willmore, An Introduction to Differential Geometry, Clarendon Press, Oxford 1959.
2. D.J.Struik, Classical Differential Geometry, Addison Wesley Publishing Company INC, Massachusetts, 1961.
3. C.E.Weatherburn, Differential Geometry of Three Dimensions, University Press, Cambridge, 1930.

15UPMAT1E19	TOPOLOGY - II	CREDITS: 4

UNIT I:

Quotient topology, embedding of manifolds, The Tychonoff Theorem, The Stone – Čech compactification.

Section 22, 36 - 38

UNIT II:

Local finiteness, The Nagata -Smirnov metrization theorem, Paracompactness – The Smirnov metrization theorem

Section 39 – 42

UNIT III:

Complete metric spaces, a Space filling curve, Compactness in metric spaces, Pointwise and Compact convergence, Ascoli theorem.

Section 43 – 47

UNIT IV:

Baire spaces, a nowhere differentiable function, Introduction to dimention theory.

Section 48 – 50

UNIT V

Homotopy of paths, The fundamental group, Covering spaces, The fundamental group of the circle.

Section 51 – 54

TEXT BOOK :

James R. Munkres, "Topology", 2nd Edition, Prentice Hall of India Pvt. Ltd., 2000. (Third Indian Reprint).

Books for Supplementary Reading and Reference:

1. J. Dugundji, "Topology", Prentice Hall of India, New Delhi, 1975.
2. George F. Simmons, "Introduction to Topology and Modern Analysis", McGraw Hill Book Co., 1963.
3. J.L. Kelly, "General Topology", Van Nostrand, Reinhold Co., New York.

15UPMAT1E20	NONLINEAR DIFFERENTIAL EQUATIONS	CREDITS: 4

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: Harmonic 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: Structure of solutions of the general linear system – Constant coefficient system – Periodic coefficients – Floquet theory – Wronskian.

UNIT V:

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

TEXT BOOK :

"Nonlinear Ordinary Differential Equations" by **D.W.Jordan and P.Smith**, Clarendon Press, Oxford, 1977.

Unit-I : Chapter 2.
Unit-II: Chapter 4.
Unit-III: Chapter 5: Sections: 5.1 - 5.4, 5.7 -5.10.
Unit-IV: Chapter 8: Sections: 8.1 - 8.4.
Unit-V: Chapter 9: Sections: 9.1 - 9.4, 9.6.

Books for Supplementary Reading and Reference:

1. *"Differential Equations"* by **G.F. Simmons**, Tata McGraw-Hill, New Delhi, 1979.
2. *"Ordinary Differential Equations and Stability Theory"* by **D.A. Sanchez**, Dover, New York, 1968.
3. *"Notes on Nonlinear Systems"* by **J.K. Aggarwal**, Van Nostrand, 1972.

15UPMAT1E21	ADVANCED PARTIAL DIFFERENTIAL EQUATIONS	CREDITS: 4

UNIT I: Laplace Equation

Introduction: Examples of PDE, Classification Transport equation: Initial-value problem, nonhomogeneous problem. Laplace Equation: Fundamental solution – Mean-value formulas – Properties of harmonic functions – Green's functions – Energy methods

UNIT II: Heat Equation

Fundamental solution – Mean-value formula – Properties of solutions – Energy methods

UNIT III: Wave Equation

Solution by spherical means – Nonhomogeneous problem – Energy methods

UNIT IV: Nonlinear First order PDE

Introduction to Hamilton Jacobi Equations: Calculus of variations, Hamilton ODE – Legendgre transform – Hopf-Lax formula. Introduction to Conservation Laws: Shocks, Entropy Condition – Lax-Oleinik Formula – Weak solutions, Uniqueness.

UNIT V: Other ways to represent solutions

Separation of variables - Similarity solutions - Transform methods - Converting nonlinear PDE into ODE.

TEXTBOOK:

L. C. EVANS, Partial Differential Equations, American Mathematical Society, Indian Edition, 2009.

Unit I:	Chapter 1 - Sections 1.1, 1.2
	Chapter 2 - Sections 2.1, 2.2
Unit II:	Chapter 2 – Section 2.3
Unit III:	Chapter 2 – Section 2.4
Unit IV:	Chapter 3 – Sections 3.3, 3.4
Unit V:	Chapter 4 – Sections 4.1 to 4.4

Books for Supplementary Reading and Reference:

1. H.Brezis, Functional Analysis, Sobolev Spaces & Partial Equation Equations, Springer, 2011.
2. F.John, Partial Differential Equations, Applied Mathematical Science Vol. 1, Springer, 1982.
3. M.Renardy and R.C.Rogers, An Introduction to Partial Differential Equations, Springer, 2004.
4. Robert McOwen, Partial Differential Equations: Methods and Applications, Pearson Education, Second Edition, 2005.

15UPMAT1S01	APPLIED MATHEMATICS – I	CREDITS: 4

UNIT I: Ordinary Differential Equations

Second and higher order linear ODE – Homogeneous linear equations with constant and variable coefficients – Nonhomogeneous equations – Solutions by variation of parameters.

UNIT II: Functions of Several Variables

Partial derivatives – Total differential – Taylor's expansions – Maxima and Minima of functions – Differentiation under integral sign.

UNIT III: Partial Differential Equations

Formation of PDE by elimination of arbitrary constants and functions – Solutions – General and singular solution- Lagrange's Linear equation – Linear PDE of second and higher order with constant coefficients.

UNIT IV: Fourier Series

Dirichlet's conditions – General Fourier series – Half range Sine and Cosine series – Parseval's identity – Harmonic Analysis.

UNIT V: Boundary Value Problems

Classifications of PDE – Solutions by separation of variables - One dimensional heat and wave equation.

Books for Supplementary Reading and Reference:

1. Kreyszig, E., "Advanced Engineering Mathematics" (8th Edition), John Wiley and Sons, (Asia) Pte Ltd., Singapore, 2000.
2. Grewal, B.S., Higher Engineering Mathematics, Thirty Eighth Edition, Khanna Publishers, Delhi 2004.

15UPMAT1S02	APPLIED MATHEMATICS – II	CREDITS: 4

UNIT I: Laplace Transform

Transform of elementary functions – Transforms of derivatives and integrals – Initial and final value theorems – Inverse Laplace transform – Convolution theorem – Solutions of linear ODE with constant coefficients.

UNIT II: Fourier Transforms

Fourier integral theorem – Fourier transform pairs– Fourier Sine and Cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval's identity.

UNIT III: Multiple Integrals

Double integration – Cartesian and polar co-ordinates – Change of order of integration – Area as a double integral – Triple integration – Volume as a triple integral.

UNIT IV: Vector Calculus

Gradient, Divergence and Curl – Directional derivative – Irrotational and solenoidal vector fields – Vector integration – Green's theorem, Gauss divergence theorem and Stoke's theorem.

UNIT-V: Numerical Solutions of ODEs

Solution by Taylor's series Method - Euler's Method – Modified Euler Method, Runge-Kutta Method – Solving simultaneous equations.

Books for Supplementary Reading and Reference:

1. Kreyszig, E., "Advanced Engineering Mathematics" (8th Edition), John Wiley and Sons, (Asia) Pte Ltd., Singapore, 2000.
2. Grewal, B.S., Higher Engineering Mathematics, Thirty Eighth Edition, Khanna Publishers, Delhi 2004.

15UPMAT1S03	NUMERICAL & STATISTICAL METHODS	CREDITS: 4

UNIT I:

Algebraic and Transcendental Equations: Bisection Method – Iteration Method – The Method of False Position – Newton- Raphson – Method.

UNIT II:

System of Linear Equation: Gauss Elimination, Gauss Jordon elimination – Triangularization method –Iterative Methods, Jacobi, Gauss-seidal iteration, Iterative method for A^{-1}.

UNIT III:

Interpolation with equal intervals – Newton forward and backward formula - Central Difference Interpolation formula – Gauss forward and backward formula – Stirling's formula – Bessel's Formula - Numerical differentiation: Maximum and minimum values of a tabulated function. Numerical Integration: Trapezoidal Rule – Simpson's Rule – Numerical double Integration.

UNIT IV:

Correlation Coefficient – Rank correlation coefficient of determination – Linear regression – Method of least squares – Fitting of the curve of the form $ax+b$, ax^2+bx+c, ab^x and ax^b – Multiple and partial correlation (3-variable only).

UNIT V:

Binominal distribution – Poisson distribution – Normal distribution – Properties and Applications.

TEXT BOOK

1. **S.S. Sastry**, Introductory Methods of Numerical Analysis, Prentice Hall of India, pvt Ltd., 1995.
2. **S.C. Gupta** and **V.K. Kapoor,** Fundamentals of Mathematical Statistics, Sultan Chand & Sons, (1994).

Books for Supplementary Reading and Reference:

1. S.Kalavathy, Numerical Methods, Vijay Nicole, Chennai, 2004.
2. Dr. Kandasamy, Numerical Methods, Sultan Chand, New Delhi.

15UPMAT1S04	STATISTICS	CREDITS: 4

UNIT I:

Collection, classification and tabulation of data, graphical and diagrammatic representation – Bar diagrams, Pie diagram, Histogram, Frequency polygon, frequency curve and Ogives.

UNIT II:

Measures of central tendency – Mean, Median and Mode in series of individual observations, Discrete series, Continuous series (inclusive), More than frequency, Less than frequency, Mid-value and open-end class.

UNIT III:

Measures of dispersion – Range, Quartile deviation, Mean deviation about an average, Standard deviation and co-efficient of variation for individual, discrete and continuous type data.

UNIT IV:

Correlation – Different types of correlation – Positive, Negative, Simple, Partial Multiple, Linear and non-Linear correlation. Methods of correlation – Karlpearson's Spearman's correlations and Concurrent deviation.

UNIT V:

Regression types and method of analysis, Regression line, Regression equations, Deviation taken from arithmetic mean of X and Y, Deviation taken from assumed mean, Partial and multiple regression coefficients – Applications

TEXT BOOK

S.C.Gupta and **V.K. Kapoor**, Fundamentals of Mathematical Statistics, Sultan Chand and Sons, New Delhi, 1994.

Books for Supplementary Reading and Reference:

1. Freund J.E. (2001); Mathematical Statistics, Prentice Hall of India.
2. Goon, A.M., Gupta M.K., Dos Gupta, B, (1991), Fundamentals of Statistics, Vol. I, World Press, Calcutta.