PERIYAR UNIVERSITY

Re-accredited with 'A' grade by the NAAC

PERIYAR PALKALAI NAGAR

SALEM - 11

M.Sc. Branch – I (B): Mathematics

(SEMESTER PATTERN)

(Under Choice Based Credit System)

(For University Department)

REGULATIONS AND SYLLABUS

(For candidates admitted from 2016-2017 onwards)

PERIYAR UNIVERSITY, SALEM –11

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

REGULATIONS AND SYLLABUS

(For the candidates admitted from 2016-2017)

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 62 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.

	Marks			No. of Subjects	Total Marks	Credits
	External	Internal	Total			
For Each Paper	75	25	100	19	1900	84
Dissertation + Viva Voce	50+50	50+50	200	1	200	8
	Grand Total			20	2100	92

5. STRUCTURE OF THE COURSE

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

ELECTIVE COURSES

S.No	COURSE CODE	TITLE OF THE COURSE	CREDITS
1.	16UPMAT1E01	Discrete Mathematics	4
2.	16UPMAT1E02	Harmonic Analysis	4
3.	16UPMAT1E03	Difference Equations	4
4.	16UPMAT1E04	Numerical Analysis	4
5.	16UPMAT1E05	Methods of Applied Mathematics	4
6.	16UPMAT1E06	Optimization Techniques	4
7.	16UPMAT1E07	Combinatorial Mathematics	4
8.	16UPMAT1E08	Fuzzy Sets and their Applications	4
9.	16UPMAT1E09	Representation Theory	4
10.	16UPMAT1E10	Non Commutative Algebra – I	4
11.	16UPMAT1E11	Non Commutative Algebra – II	4
12.	16UPMAT1E12	Commutative Algebra	4
13.	16UPMAT1E13	Control Theory	4
14.	16UPMAT1E14	Stochastic Differential Equations	4
15.	16UPMAT1E15	Distribution Theory	4
16.	16UPMAT1E16	Number Theory	4
17.	16UPMAT1E17	Differential Geometry	4
18.	16UPMAT1E18	Topology – II	4
19.	16UPMAT1E19	Partial Differential Equations – II	4
20.	16UPMAT1E20	Nonlinear Differential Equations	4
21.	16UPMAT1E21	Mathematical Biology	4
22.	16UPMAT1E22	Fluid Dynamics	4
23.	16UPMAT1E23	MatLab	4

SUPPORTIVE COURSES

S.No	COURSE CODE	TITLE OF THE COURSE	CREDITS
1.	16UPMAT1S01	Applied Mathematics – I	4
2.	16UPMAT1S02	Applied Mathematics – II	4
3.	16UPMAT1S03	Numerical & Statistical Methods	4
4.	16UPMAT1S04	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: 3 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

The components of 40 marks are

Periodical assessment	- 20 marks
Test (best 2 out of 3)	- 10 marks
Record	- 10 marks

The components of 60 marks are

Experiments	- 40 marks
Viva-voce	- 10 marks
Record	- 10marks

Passing Minimum : **30 Marks** (Aggregate of Experiments, Viva-voce 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 2016-17, that is, for students who are admitted to the first year of the programme during the academic year 2016-17 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:

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.

(c) 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 DISSERTATION

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)

Submitted to

Department of Mathematics

Periyar University, 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

16UPMAT1C01	LINEAR ALGEBRA	CREDITS: 5

UNIT I: Linear transformations

The algebra of Linear transformations – Isomorphism of vector spaces – Representations of linear transformations by matrices – Linear functionals – The double dual – the transpose of a linear transformation.

UNIT II: Algebra of polynomials

The algebra of polynomials – Lagrange interpolation – Polynomial ideals - The prime factorization of a polynomial - Determinant functions.

UNIT III: Determinants

Permutations and the uniqueness of determinants – Classical adjoint of a (square) matrix – Inverse of an invertible matrix using determinants – Characteristic values – Annihilating polynomials.

UNIT IV: Diagonalization

Invariant subspaces – Simultaneous triangulations – Simultaneous diagonalization – Direct-sum decompositions – Invariant sums – Primary decomposition theorem.

UNIT V: The Rational and Jordan forms

Cyclic subspaces and annihilators – Cyclic decompositions and the rational form – The Jordan form - Computation of invariant factors.

TEXT BOOK:

Kenneth M Hoffman and **Ray Kunze**, Linear Algebra, 2nd Edition, Prentice-Hall of India Pvt. Ltd, New Delhi, 2013.

UNIT	Chapter(s)	Sections
I	3	3.1 – 3.7
II	4 & 5	4.1 – 4.5 and 5.1, 5.2
III	5 & 6	5.3, 5.4 and 6.1 – 6.3
IV	6	6.4 – 6.8
V	7	7.1 – 7.4

BOOKS FOR SUPPLEMENTARY READING AND REFERENCES:

1. **M. Artin**, *"Algebra"*, Prentice Hall of India Pvt. Ltd, 2005.
2. **S.H. Friedberg, A.J. Insel and L.E Spence**, *"Linear Algebra*", 4th Edition, Pritice-Hall of India Pvt. Ltd. 2009.
3. **I.N. Herstein**, *"Topics in Algebra*", 2nd Edition, Wiley Eastern Ltd, New Delhi, 2013.
4. **J.J. Rotman**, *"Advanced Modern Algebra*", 2nd Edition, Graduate Studies in Mathematics, Vol. 114, AMS, Providence, Rhode Island, 2010.
5. **G. Strang**, *"Introduction to Linear Algebra*", 2ndEdition, Prentice Hall of India Pvt. Ltd, 2013.

16UPMAT1C02	REAL ANALYSIS	CREDITS: 5

UNIT I: Basic Topology

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

UNIT II: 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.

UNIT III: Riemann – Stieltjes Integral

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

UNIT IV: 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.

UNIT V: 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.

TEXT BOOK:

Walter Rudin, ***"Principles of Mathematical Analysis"***, 3rd Edition, McGraw Hill Book Co., Kogaskusha, 1976.

UNIT	Chapter(s)	Pages
I	**2 & 4**	24 – 30, 36 – 40, 89 – 95
II	**5**	103 – 119
III	**6**	120 – 142
IV	**7**	143 – 171
V	**8**	172 – 203

BOOKS FOR SUPPLEMENTARY READING AND REFERENCES:

1. **T.M. Apostol**, *"Mathematical Analysis*", Narosa Publishers, New Delhi,1985.
2. **A. Browder, "***Mathematical Analysis, An Introduction"*, Springer-Verlag, New York, 1996.
3. **K.A. Ross,** *"Elementary Analysis: The Theory of Calculus",* 2nd Edition, Springer, New York, 2013.
4. **H.H.Sohrab,** *"Basic Real Analysis*", Springer International Edition, India, 2006.
5. **M. Stoll,** *"Introduction to Real Analysis",* 2nd Edition, Addison-Wesley Longman Inc, 2001.

16UPMAT1C03	ORDINARY DIFFERENTIAL EQUATIONS	CREDITS: 5

UNIT I: Linear Equations with Constant Coefficients

Introduction – The second order homogeneous equation - Initial value problems for second order equations - Linear dependence and independence – A formula for Wronskian.

UNIT II: Linear Equations with Constant Coefficients

The non-homogeneous equation of order two – The homogeneous equation of order n - Initial value problems for n-th order equations - The non-homogeneous equation of order n – A special method for solving the non-homogeneous equation.

UNIT III: Linear Equations with Variable Coefficients

Introduction - Initial value problems for the homogeneous equation – Solutions of the homogeneous equation – The Wronskian and linear independence - Reduction of the order of a homogeneous equation – The Legendre Equation.

UNIT IV: Linear Equations with Regular Singular Points

Introduction - The Euler equation - Second order equations with regular singular points – The Bessel Equation - The Bessel Equation(continued).

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

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

TEXT BOOK:

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

UNIT	Chapters	Sections
I	**2**	1 – 5
II	**2**	6, 7, 8, 10, 11
III	**3**	1 – 5, 8
IV	**4**	1, 2, 3, 7, 8
V	**5**	1 – 6

BOOKS FOR SUPPLEMENTARY READING AND REFERENCES:

1. **R.P. Agarwal and R. 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.

16UPMAT1C04	MECHANICS	CREDITS: 5

UNIT I: Mechanical Systems

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

UNIT II : Lagrange's Equations

Derivation of Lagrange's Equations – Examples – Integrals of the motion

UNIT III: Hamilton's Equations

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

UNIT IV: Hamilton – Jacobi Theory

Hamilton Principle Function – Hamilton-Jacobi Equation – Separability.

UNIT V: Canonical Transformation

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

TEXT BOOK:

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

UNIT	Chapter	Sections
I	**1**	1.1 to 1.5
II	**2**	2.1 to 2.3
III	**4**	4.1 to 4.3
IV	**5**	5.1 to 5.3
V	**6**	6.1 to 6.3

BOOKS FOR SUPPLEMENTARY READING AND REFERENCES:

1. **H. Goldstein**, *"Classical Mechanics",* 2nd Edition, Narosa Publishing House, New Delhi.
2. **R.D. Gregory**, *"Classical Mechanics"*, Cambridge University Press, 2006
3. J**.L.Synge and B.A.Griffth**, *"Principles of Mechanics*", 3rd Edition, McGraw Hill Book Co., New York, 1970.

16UPMAT1C05	ABSTRACT ALGEBRA	CREDITS: 5

UNIT I:

Another Counting Principle – Sylow's Theorem.

UNIT II:

Direct Products – Finite Abelian Groups – Polynomial Rings.

UNIT III:

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

UNIT IV:

More about Roots – The Elements of Galois Theory.

UNIT V:

Solvable groups – Solvability by Radicals - Finite Fields.

TEXT BOOK:

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

UNIT	Chapter(s)	Sections
I	**2**	2.11 & 2.12
II	**2 & 3**	2.13, 2.14, 3.9
III	**3 & 5**	3.10, 5.1, 5.3
IV	**5**	5.5 & 5.6
V	**5 & 7**	5.7, 7.1

BOOKS FOR SUPPLEMENTARY READING AND REFERENCES:

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. **V. K. Khanna and S.K. Bhambri,** *"A Course in Abstract Algebra"*, Vikas Publishing House Pvt Limited, 1993.

16UPMAT1C06	ADVANCED REAL ANALYSIS	CREDITS: 5

UNIT I:

Double Sequences - Double Series - Rearrangement Theorem for Double Series - A Sufficient Condition for Equality of Iterated Series - Multiplication of Series - Cesaro Summability - Infinite Products - Euler's Product for the Riemann zeta Function.

UNIT II:

Linear Transformations – Differentiation – The Contraction Principle – The Inverse Function Theorem - The Implicit Function Theorem.

UNIT III:

The Rank theorem – Determinants – Derivatives of Higher Order – Differentiation of Integrals.

UNIT IV:

Integration – Primitive Mappings – Partitions of Unity - Change of Variables - Differential Forms

UNIT V:

Simplexes and Chains – Stoke's Theorem – Closed Forms and Exact Forms – Vector Analysis.

TEXT BOOK:

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

UNIT	Chapter & Book	Sections/Pages
I	8 of [1]	8.20 – 8.27
II	9 of [2]	204 – 228
III	9 of [2]	228 – 244
IV	10 of [2]	245 – 266
V	10 of [2]	266 – 299

BOOKS FOR SUPPLEMENTARY READING AND REFERENCES:

1. H.L. Royden, Real Analysis, Macmillan Publ. Co. INC., 4th Edition, New York, 1993.
2. W.Fleming, Functions of Several Variables, 2nd Edition, Springer-Verlag, New York, 1977.
3. V. Ganapathy Iyer, Mathematical Analysis, Tata MC Graw Hill, New Delhi, 1970.
4. M.Moskowitz and F.Paliogiannis, Functions of Several Real Variables, World Scientific Publ. Co.Pte.Ltd., Singapore, 2011.

16UPMAT1C07	PARTIAL DIFFERENTIAL EQUATIONS - I	CREDITS: 5

UNIT I: Partial differential equations of first order

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

Linear partial differential equations with constant coefficients – Equations with variable coefficients – The solution of linear hyperbolic equations – Separation of variables – Nonlinear equations of the second order.

UNIT III: Laplace's Equation

Elementary solution of Laplace's equation – Families of equipotential surfaces – Boundary value problems – Separation of variables **–** The theory of Green's function for Laplace equation.

UNIT IV: The wave equation

Elementary solutions of the one-dimensional wave equation – Vibrating membranes: Applications of the calculus of variations – Three dimensional problems – Green's function for the wave equation.

UNIT V: The Diffusion Equation

Elementary solutions of the diffusion equation – Separation of variables **–** The use of Green's functions.

TEXT BOOK:

I.N. Sneddon, Elements of Partial Differential Equations, Dover, Singapore, 2006.

UNIT	Chapter	Sections
I	2	7 – 11, 13
II	3	4, 5, 8, 9, 11
III	4	2 – 5, 8
IV	5	2, 4, 5, 7
V	6	3, 4, 6

BOOKS FOR SUPPLEMENTARY READING AND REFERENCES:

1. D. Colton, Partial Differential Equations: An Introduction, Dover Publishers, New York, 1988.
2. H. Hattori, Partial Differential Equations: Methods, Applications and Theories, World Scientific, Singapore, 2013.
3. M.D.Raisinghania, Advanced Differential Equations, S. Chand & Company, New Delhi, 2013.
4. K. Sankara Rao, Introduction to Partial Differential Equations, Second Edition, Prentice – Hall of India, New Delhi, 2006.

16UPMAT1C08	TOPOLOGY - I	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.

UNIT II: Continuous Functions

Continuous functions – The product topology – The metric topology.

UNIT III: Connectedness

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

UNIT IV: Compactness

Compact spaces – Compact subspaces of the real line – Limit point compactness – Local compactness.

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.

TEXT BOOK:

J. R. Munkres, *"Topology",* 2nd Edition, Prentice Hall of India Pvt. Ltd., 2000.

UNIT	Chapter	Sections
I	2	12 – 17
II	2	18 – 21
III	3	23 – 25
IV	3	26 – 29
V	4	30 – 35

BOOKS FOR SUPPLEMENTARY READING AND REFERENCES:

1. **J. Dugundji,** *"Topology"*, Prentice Hall of India, New Delhi, 1975.
2. **G.F.Simmons,** ***"****Introduction to Topology and Modern Analysis"*, Tata McGraw-Hill Book Co., New Delhi, 2004.
3. **J.L. Kelly,** *"General Topology"*, Springer-Verlag, New York, 1975.

16UPMAT1C09	COMPLEX ANALYSIS	CREDITS: 5

Unit I:

The spherical representation of complex numbers – Introduction to the concept of analytic functions - Elementary theory of power series – The Exponential and Trigonometric functions.

Unit II:

Conformality - Linear transformations - Elementary conformal mappings.

Unit III:

Fundamental theorems - Cauchy's integral formula –Local properties of analytic functions.

Unit IV:

The general form of Cauchy's theorem - Calculus of residues.

Unit V:

Harmonic functions – Power series expansions.

TEXT BOOK:

L.V. Ahlfors, *"Complex Analysis*", 3rd Edition, McGraw-Hill Education, New Delhi, 1979.

UNIT	Chapter(s)	Section(s)
I	1	2, 4
	2	1 – 3
II	3	2 – 4
III	4	1 – 3
IV	4	4 & 5
V	4	6
	5	1

BOOKS FOR SUPPLEMENTARY READING AND REFERENCES:

1. **J.B. Conway,** *"Functions of One Complex Variable",* 2nd Edition, Springer-Verlag, New York, 1978.
2. **S. Lang,** *"Complex Analysis*", 4th Edition, Springer-Verlag, New York, 1999.
3. **S. Ponnusamy,** "*Foundations of Complex Analysis*", 2nd Edition, Alpha Science International, 2005.

16UPMAT1C10	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.

UNIT II: Connectivity, Euler tours and Hamilton Cycles

Connectivity - Blocks - Euler tours – Hamilton Cycles.

UNIT III: Matchings, Edge Colourings

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

UNIT IV: Independent sets and Cliques, Vertex Colourings

Independent sets - Ramsey's Theorem - Chromatic Number - Brooks' Theorem – Chromatic Polynomials.

UNIT V:Planar graphs

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

TEXT BOOK:

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

UNIT	Chapter	Sections
I	1 & 2	1.1 – 1.7, 2.1 – 2.4
II	3 & 4	3.1, 3.2, 4.1, 4.2
III	5	5.1 – 5.3, 6.1, 6.2
IV	7	7.1, 7.2, 8.1, 8.2, 8.4
V	9	9.1 – 9.3, 9.6

BOOKS FOR SUPPLEMENTARY READING AND REFERENCES:

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.

16UPMAT1C11	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.

UNIT II: Parameters of the Distribution

Expected values – Moments – The Chebyshev Inequality – Absolute moments – Order parameters – Moments of random vectors – Regression of the first and second types.

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.

UNIT IV: Some Probability Distributions

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

UNIT V: Limit Theorems

Stochastic convergence – Bernoulli's law of large numbers – The convergence of sequence of distribution functions – The Levy-Cramer Theorems – The De Moivre-Laplace Theorem – The Lindberg Theorem – Lyapunov Theroem – Poisson's, Chebyshev's, Khintchine's law of large numbers – Strong law of large numbers

TEXT BOOK:

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

UNIT	Chapter	Sections
I	1 & 2	1.1 – 1.7 & 2.1 – 2.9
II	3	3.1 – 3.8
III	4	4.1 – 4.7

IV	**5**	**5.1 – 5.10**
V	**6**	**6.2 – 6.4, 6.6 – 6.9, 6.11, 6.12**

BOOKS FOR SUPPLEMENTARY READING AND REFERENCES:

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.

16UPMAT1C12	MEASURE THEORY AND INTEGRATION	CREDITS: 5

UNIT I: Lebesgue Measure

Introduction – Outer measure - Measurable sets and Lebesgue measure – Measurable functions - Littlewood's three principles.

UNIT II: 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.

UNIT III: Differentiation and Integration

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

UNIT IV: General Measure and Integration

Measure spaces – Measurable functions – Integration - General convergence theorems – Signed Measure – The Radon - Nikodym theorem.

UNIT V: Measure and Outer Measure

Outer measure and measurability – The Extension theorem – Product measures.

TEXT BOOK:

H.L. Royden, Real Analysis, 3rd Edition, Macmillan Publishing Company, New York, 1988.

UNIT	Chapter	Sections
I	3	1 – 3, 5 & 6
II	4	1 – 4
III	5	1 – 4
IV	11	1 – 3, 5, 6
V	12	1, 2, 4

BOOKS FOR SUPPLEMENTARY READING AND REFERENCES:

1. Robert G. Bartle, The Elements of Integration and Lebesgue Measure, 2nd Edition, Wiley-Blackwell, 1995.
2. G. De Barra, Measure Theory and Integration, 2nd Edition, Horwood, Publishing, 2003.

3. W.Rudin, Real and Complex Analysis, 3rd Edition, Tata McGraw-Hill Education, New Delhi, 2013.

16UPMAT1C13	FUNCTIONAL ANALYSIS	CREDITS: 5

UNIT I: Banach Spaces

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

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.

UNIT III: Hilbert Spaces

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

UNIT IV: Operation on Hilbert spaces

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

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.

TEXT BOOK:

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

UNIT	Chapter(s)	Sections
I	9	46 – 48
II	9 & 10	49 – 51, 52
III	10	53 – 56
IV	10	57 – 59
V	12	64 - 69

BOOKS FOR SUPPLEMENTARY READING AND REFERENCES:

1. **G. Bachman and L. Narici**, *"Functional Analysis"*, Academic Press, New York, 1966.
2. **H.C. Goffman and G. Fedrick,** *"First Course in Functional Analysis*", Prentice Hall of India, New Delhi, 1987.
3. **E.Kreyszig**, *"Introductory Functional Analysis with Applications*", John Wiley & Sons, New York, 1978.

4. **E.S.Suhubi**, *"Functional Analysis*", Springer International Edition, India, 2009.

16UPMAT1E01	DISCRETE MATHEMATICS	CREDITS: 4

UNIT I: The Foundation of Logic

Logic – Propositional equivalence – Predicates and quantifiers – Proof Methods and Strategy – 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, 7th Edition, WCB/ McGraw Hill Publications, New Delhi, 2011.

UNIT	Chapter(s)	Sections
I	1 & 3	1.1 – 1.3, 1.8, 3.2
II	5	5.1 – 5.6
III	6	6.1, 6.2, 6.4
IV	10	10.1 – 10.4
V	12	12.2, 12.3, 12.5

BOOKS FOR SUPPLEMENTARY READING AND REFERENCES:

1. **Edward A. Bender and S. Gill Williamson**, *"A Short Course in Discrete Mathematics",* Dover Publications, 2006.
2. **M.O. Albertson and J.P. Hutchinson**, *"Discrete Mathematics with Algorithms*", John Wiley & Sons, 2008.

3. **Rajendra Akerkar and Rupali Akarkar**, *"Discrete Mathematics*", Pearson Education Pvt. Ltd, Singapore, 2004.
4. **J.P. Trembley and R. Manohar**, *"Discrete Mathematical Structures*", Tata McGraw Hill, New Delhi, 1997.
5. **Martin Aigner**, *"A Course in Enumeration"*, Springer-Verlag, Heidelberg, 2007.
6. **J.H. Van Lint, R.M. Wilson**, *"A Course in Combinatorics"*, 2nd Edition, Cambridge University Press, Cambridge, 2001.

16UPMAT1E02	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.

UNIT II:

The Classical kernels – Summability – Metric theorems - Pointwise summability - Positive definite sequences - Herglotz's theorem

UNIT III:

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

UNIT IV:

The Plancherel theorem - Another convergence theorem - The Poisson summation formula - Bockner's theorem - The Continuity theorem.

UNIT V:

Characters of discrete groups - Characters of compact groups - Bockner's theorem, Examples - Minkowski's theorem.

TEXT BOOK:

H. Helson, Harmonic Analysis, 2nd Edition, Hindustan Book Agency, New Delhi, 1995.

UNIT	Chapter	Sections
I	1	1.1 – 1.4
II	1	1.5 – 1.8
III	1	1.9, 1.10, 2.1, 2.2
IV	2	2.3 – 2.6
V	3	3.1 – 3.5

BOOKS FOR SUPPLEMENTARY READING AND REFERENCES:

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.

16UPMAT1E03	DIFFERENCE EQUATIONS	CREDITS: 4

UNIT I: Difference Calculus

Difference operator - Summation – Generating functions and approximate summation.

UNIT II: Linear Difference Equations

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

UNIT III: Linear Difference Equations

Equations with variable coefficients – The z -transform.

UNIT IV: Stability Theory

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

UNIT V: Asymptotic Methods

Introduction – Asymptotic analysis of sums – Linear equations.

TEXT BOOK:

W.G. Kelley and **A.C. Peterson,** *"Difference Equations"*, 2nd Edition, Academic Press, New York, 2001.

UNIT	Chapter	Sections
I	2	2.1 – 2.3
II	3	3.1 – 3.3
III	3	3.5, 3.7
IV	4	4.1, 4.2
V	5	5.1 – 5.3

BOOKS FOR SUPPLEMENTARY READING AND REFERENCES:

1. **R.P. Agarwal**, *"Difference Equations and Inequalities*", 2nd Edition, Marcel Dekker, New York, 2000.
2. **S.N. Elaydi**, "*An Introduction to Difference Equations*", 3rd Edition, Springer, India, 2008.
3. **R. E. Mickens**, *"Difference Equations*", 3rd Edition, CRC Press, 2015.

16UPMAT1E04	NUMERICAL ANALYSIS	CREDITS: 4

Unit I:

Newton's Method and its Extensions – Error Analysis for Iterative Methods – Interpolation and the Lagrange Polynomial – Hermite Interpolation – Cubic Spline Interpolation.

Unit II:

Numerical Differentiation – Elements of Numerical Integration – Romberg Integration

Unit III:

Elementary Theory of Initial Value Problems – Euler's Method – Taylor Method – Runge-Kutta Methods.

Unit IV:

Multistep Methods – Higher-Order Equations and Systems of Differential Equations – Stability.

Unit V:

Elliptic Partial Differential Equations – Parabolic Partial Differential Equations - Hyperbolic Partial Differential Equations.

TEXT BOOK:

R. L. Burden and J.D. Faires, *"Numerical Analysis*", 9th Edition, Thomson Learning. Inc., Stanford, Connecticut, 2011.

UNIT	Chapter(s)	Sections
I	2 & 3	2.3, 2.4, 3.1, 3.4, 3.5
II	4	4.1, 4.3, 4.5
III	5	5.1, 5.2, 5.4
IV	5	5.6, 5.9, 5.10
V	12	12.1 – 12.3
Algorithms are not included in the syllabus		

BOOKS FOR SUPPLEMENTARY READING AND REFERENCES:

1. **C.F. Gerald and P.O. Wheatley**, "*Applied Numerical Analysis"* Sixth Edition, Addison- Wesley, Reading, 1998.
2. **M.K. Jain,** "*Numerical Methods for Scientific and Engineering Computation*" New Age International, 2003.

16UPMAT1E05	METHODS OF APPLIED MATHEMATICS	CREDITS: 4

UNIT I: Calculus of variations

Maxima and Minima – The simplest case – Examples - Natural and transition boundary conditions – The variational notation – The more general case – Constraints and Lagranges multipliers – Variable end points – Sturm-Liouville problems.

UNIT II: Applications of Calculus of variations

Hamilton's principle – Lagrange's equation – Generalized dynamical entities – 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 – The Green's function – Fredholm equations with separable kernels – Example.

UNIT IV: Integral Equations

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

UNIT V: Special devices

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

TEXT BOOK:

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

UNIT	Chapter	Sections
I	2	2.1 – 2.9
II	2	2.10 – 2.14, 2.16, 2.19
III	3	3.1 – 3 .3, 3.6, 3.7
IV	3	3.8 – 3.12
V	3	3.13 – 3.15

BOOKS FOR SUPPLEMENTARY READING AND REFERENCES:

1. **R.P. Kanwal,** "*Linear integral equation: Theory and Techniques*", 2nd Edition, Birkhäuser, 1996.
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*", University Press of the Pacific, 2003.

16UPMAT1E06	OPTIMIZATION TECHNIQUES	CREDITS: 4

UNIT I: Linear Programming Problems

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

UNIT II: Decision Analysis and Games

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

UNIT III: Inventory Models - Deterministic Models

Inventory Models **-** Probabilistic Models

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.

TEXT BOOK:

Hamdy A Taha, Operations Research: An Introduction, 7th Edition, Prentice – Hall of India, New Delhi, 2003.

UNIT	Chapter(s)	Sections
I	4 & 7	4.4, 7.2, 9.1, 9.2
II	14	14.1 – 14. 4
III	11 & 16	11.1 – 11.3, 16.1
IV	17	17.2 – 17.7 (Omit 17.6.4)
V	20	20.1, 20.2

BOOKS FOR SUPPLEMENTARY READING AND REFERENCES:

1. **F.S.Hillier and G.J.Lieberman**, *"Introduction to Operations Research,* 4th Edition, Mc Graw Hill Book Company, New York, 1989.
2. **D.T. Philips, A. Ravindra and J. Solberg,** *"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.

16UPMAT1E07	COMBINATORIAL MATHEMATICS	CREDITS: 4

UNIT I: Permutations and Combinatorics

The Rules of sum and product – Permutations – Combinations – Distributions of distinct objects – Distribution of nondistinct objects – Strlimg's formula

UNIT II: Generating Functions

Generating functions for combinations – Enumerators for permutations- Distributions of distinct objects into nondistinct cells – Partitions of integers – The Ferrers graph – Elementary relations.

UNIT III: Recurrence relations

Linear recurrence relations with constant coefficients – Solution by the technique of generating functions – A special class of nonlinear difference equations – Recurrence relations with two indices.

UNIT IV: The Principle of inclusion and exclusion

The Principle of inclusion and exclusion – The general formula – Derangements – Permutations with restrictions on relative positions – The rook polynomials – Permutations with forbidden positions.

UNIT V: Polya's theory of counting

Sets, relations and groups – Equivalence classes under a permutation group – Equivalence classes of functions – Polya's fundamental theorem – Generalization of Polya's theorem.

TEXT BOOK

C.L.Liu, *"Introduction to Combinatorial Mathematics",* McGraw Hill Book Company, New York, 1968.

UNIT	Chapter(s)	Sections
I	1	1.1 – 1.7
II	2	2.1 – 2.7
III	3	3.1 – 3.5
IV	4	4.1 – 4.7
V	5	5.1 – 5.7

BOOKS FOR SUPPLEMENTARY READING AND REFERENCES:

1. **Murray Edelberg and C. L. Liu,** *"Solutions to Problems in Introduction to Combinatorial Mathematics"*, MC Grow-Hill Book & Co., New York, 1968.
2. **R.P. Stanley**, *"Enumerative Combinatorics*", Volume I, 2nd Edition, Cambridge Studies in Advanced Mathematics (Book 49)s, Cambridge University Press, 1997.
3. **P.J. Cameron,** *"Combinatorics: Topics, Techniques, Algorithms*", Cambridge University Press, Cambridge, 1998.
4. **Miklos Bona**, *"A Walk through Combinatorics*", World Scientific Publishing Company, 2002.
5. **M. Aigner**, *"A Course in Enumeration*", Springer-Verlag, Heidelberg, 2007.
6. **J.H. Van Lint and R.M. Wilson**, *"A Course in Combinatorics*", 2nd Edition, Cambridge University Press, Cambridge, 2001.

16UPMAT1E08	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 $\alpha-$cuts.

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

UNIT III: Operations on Fuzzy sets

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

UNIT IV: Fuzzy Arithmetic

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

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

TEXT BOOK:

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

UNIT	Chapter(s)	Sections
I	1 & 2	1.3 – 1.5, 2.1
II	2 & 3	2.2, 2.3, 3.1, 3.2
III	3	3.3 – 3.6
IV	4	4.1 – 4.4
V	10	10.1 – 10.7

BOOKS FOR SUPPLEMENTARY READING AND REFERENCES:

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.

16UPMAT1E09	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 – Consequences of Maschke's theorem – Schur's lemma – Irreducible modules and the group algebra.

UNIT III: More on the group algebra

More on the group algebra – The spaces of FG-homeomorphisms – Conjugacy classes - Conjugacy class sizes – Characters – The values of a character – The regular character

UNIT IV: Irreducible characters

Inner product of characters – Applications – Decomposing CG-modules – Class functions – 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.

UNIT	Chapter(s)
I	3 – 6
II	7 – 10
III	11 – 13
IV	14 – 15
V	16 – 18

BOOKS FOR SUPPLEMENTARY READING AND REFERENCES:

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.

16UPMAT1E10	NON COMMUTATIVE ALGEBRA – I	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.

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.

UNIT III: Categories and Functors:

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

UNIT IV: Projectives, Injectives and Flats:

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

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.

TEXT BOOK:

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

UNIT	Chapter(s)	Sections
I	1 & 2	1.1 – 1.5, 2.1 – 2.4
II	3	3.1 – 3.7
III	4	4.1 – 4.7
IV	5	5.1 – 5.6
V	6	6.1 – 6.6

BOOKS FOR SUPPLEMENTARY READING AND REFERENCES:

1. **T.Y. Lam**, *"Lectures on Modules and Rings*", Graduate Texts in Mathematics, Vol. 189, Springer-Verlag, Berlin-Heidelberg, New York, 1999.
2. **J. Lambek,** *"Lectures on Rings and Modules*", 3rd Edition, AMS Chelsea Publishing, AMS, Providence, Rhode Island, 2009.
3. **D.S. Passman,** *"A Course in Ring Theory"*, AMS Chelsea Publishing, AMS, Providence, Rhode Island, 2004.
4. **L.R. Veramani,** *"An Elementary Approach to Homological Algebra"*, Chapman & Hall / CRC Monographs and Surveys in Pure and Applied Mathematics. Vol. 130, CRS Press, LLC, Florida, 2003.

16UPMAT1E11	NONCOMMUTATIVE ALGEBRA – II	CREDITS: 4

UNIT I: Integral Domains

Principal ideal domains – factorial rings – Euclidean domains – Rings of fractions and quotient fields – Polynomial rings over fractional rings – Gauss Lemma – Chinese remainder theorem – Smith normal form over a PID – Finitely generated modules over a PID – The Frobenius theorem.

UNIT II: Dedekind domains

Integral closure – Dedekind domains – Hereditary domains – Discrete valuation rings – Finitely generated modules over Dedekind domains – Purifier rings.

UNIT III: Goldie rings

The Ore condition – Classical rings of fractions – Prime and semiprime rings – Gordie rings – Gordie's theorem.

UNIT IV: Semiperfect rings

Local and semilocal rings – noncommutative discrete valuation rings – Lifting idempotent – semiperfect rings – Projective covers – the Krull-Schmidt theorem – Perfect rings.

UNIT V: Serial rings

Equivalent Categories – Progenerator – The Morita theorem – Finitely presented modules – The Drozd-Warfield theorem – The Ore condition for serial rings – minors of serial right Noetherian rings.

TEXT BOOK:

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

UNIT	Chapter(s)	Sections
I	7	
II	8	
III	9	
IV	10	10.1 – 10.5
V	10 & 13	10.6, 10.7, 13.1 – 13.3
Proposition 13.3.5 is omitted		

BOOKS FOR SUPPLEMENTARY READING AND REFERENCES:

1. **P.E. Bland**, *"Rings and their Modules*", Walter de GmbH Co.KG, Berlin New York, 2011.
2. **T.Y Lam**, *"Lectures on Rings and Modules"*, Springer-Verlag, New York, Berlin, 1998.
3. **J.C. Mc Connel and J.C. Robson**, *"Noncommutative Noetherian Rings*", Graduate Studies in Mathematics, Vol.30, AMS, Providence, 2001.
4. **D. Passman**, *"A Course in Ring Theory*", AMS, Providence, 2004.
5. **G. Puninski**, *"Serial Rings"*, Kluwer Academic Publishers, Dordecht, 2001.

16UPMAT1E12	COMMUTATIVE ALGEBRA	CREDITS: 4

Unit I

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

Unit II

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

Unit III

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

Unit IV

Chain conditions – Primary decomposition in Noethorian rings.

Unit V

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

TEXT BOOK:

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

UNIT	Chapter(s)	Pages
I	1, 2	1 - 24
II	2, 3	24 - 49
III	4, 5	50 - 73
IV	6, 7	74 – 88
V	8, 9	89 – 99

BOOKS FOR SUPPLEMENTARY READING AND REFERENCES:

1. **N.S. Gopalakrishnan**, *"Commutative Algebra"*, Oxonian Press Pvt. Ltd, New Delhi, 2015.
2. **I. Kaplansky**, *"Commutative Rings*", University of Chicago Press, Chicago, 1974.
3. **H. Matsumura,** *"Commutative Ring Theory*", Cambridge University Press, 1986.

16UPMAT1E13	CONTROL THEORY	CREDITS: 4

Unit-I: Observability

Linear Systems – Nonlinear Systems

Unit-II: Controllability

Linear systems – Nonlinear systems

Unit-III: Stability

Stability – Perturbed linear systems – Nonlinear systems.

Unit IV: Stabilizability

Stabilization via linear feedback control – The controllable subspace – Stabilization with restricted feedback.

Unit V: Optimal Control

Linear time varying systems – Linear time invariant systems – Nonlinear Systems.

TEXT BOOK

K.Balachandran and **J.P.Dauer**, "*Elements of Control Theory"*, 2nd Edition (revised), Alpha Science International Ltd, 2011.

UNIT	Chapter(s)	Sections
I	2	2.1 – 2.3
II	3	3.1, 3.2
III	4	4.1 – 4.3, 4.5
IV	5	5.1 – 5.4
V	6	6.1 – 6.3

Books for Supplementary Reading and REFERENCES:

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.

16UPMAT1E14	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.

Unit II: Itô Formula and Martingale Representation Theorem

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

Unit III: Stochastic Differential Equations

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

Unit IV: The Filtering Problem

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

Unit V: Diffusions: Basic Properties

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

TEXT BOOK:

B. Oksendal, *Stochastic Differential Equations: An Introduction with Applications,* 6th Edition, Springer - Verlag, Heidelberg, 2003.

UNIT	Chapter(s)	Pages
I	2 & 3	2.1, 2.2, 3.1 – 3.3
II	4	4.1 – 4.3
III	5	5.1 – 5.3
IV	6	6.1 – 6.3
V	7	7.1 – 7.5

BOOKS FOR SUPPLEMENTARY READING AND REFERENCES:

1. A. Friedman, Stochastic Differential Equations and Application, Dover Publications, 2006.
2. L. Arnold, Stochastic Differential Equations: Theory and Applications, Dover Publications, 2011.

3. D. Henderson and P. Plaschko, Stochastic Differential Equations in Science and Engineering, World Scientific, 2006.

16UPMAT1E15	DISTRIBUTION THEORY	CREDITS: 4

Unit - I: Test functions and Distributions

Test functions - Distributions - Localization and regularization - Convergence of distributions - Tempered distributions.

Unit - II: Derivatives and Integrals

Basic Definitions - Examples - Primitives and ordinary differential equations.

Unit - III: Convolutions and Fundamental Solutions

The direct product of distributions - Convolution of distributions – Fundamental solutions.

Unit - IV: The Fourier Transform

Fourier transforms of test functions - Fourier transforms of tempered distributions- The fundamental solution for the wave equation-Fourier transform of convolutions-Laplace transforms.

Unit - V: Green's Functions

Boundary-Value problems and their adjoints - Green's functions for boundary-Value problems- Boundary integral methods.

Text book:

1. **M. Renardy and R.C.Rogers**, "*An Introduction to Partial Differential Equations"* by Second Edition, Springer Verlag, New York, 2008.

UNIT	Chapter	Sections
I	5	5.1
II	5	5.2
III	5	5.3
IV	5	5.4
V	5	5.5

BOOKS FOR SUPPLEMENTARY READING AND REFERENCES:

1. **L. Hörmander** , "*The Analysis of Linear Partial Differential Operators I – Distribution Theory and Fourier Analysis"* , Second Edition, Springer Verlag, Berlin, 2003.
2. **F.G. Friedlander and M. Joshi**, "*Introduction to the Theory of Distributions*"**,** Cambridge University Press,UK, 1998.

3. **R.P. Kanwal**, "*Generalized Functions - Theory and Technique"*, Academic Press, New York, 1983.

16UPMAT1E16	NUMBER THEORY	CREDITS: 4

Unit I: Divisibility and Congruences

Divisibility – Primes – Congruences – Solutions of Congruences.

Unit II: Congruences

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

Unit III: Quadratic Reciprocity and Quadratic Forms

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

Unit IV: Some Functions of Number Theory

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

Unit V: Some Diophantine Equations

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

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.

UNIT	Chapter(s)	Sections
I	1 & 2	1.2, 1.3, 2.1, 2.2
II	2	2.3, 2.6 – 2.9
III	3	3.1 – 3.3, 3.6
IV	4	4.1 – 4.3, 4.5
V	5	5.1 – 5.4

BOOKS FOR SUPPLEMENTARY READING AND REFERENCES:

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.

16UPMAT1E17	DIFFERENTIAL GEOMETRY	CREDITS: 4

UNIT I: Space Curves

Definition of a space curve – Arc length – Tangent – Normal and binormal – Curvature and torsion – Contact between curves and surfaces – Tangent surface – Involutes and evolutes – Intrinsic equations – Fundamental existence theorem for space curves – Helics.

UNIT II: Intrinsic Properties of a Surface

Definition of a surface – Curves on a surface – Surface of revolution – Helicoids – Metric – Direction coefficients – Families of curves – Isometric correspondence – Intrinsic properties.

UNIT III: Geodesics

Geodesics – Canonical geodesic equations – Normal property of geodesics – Existence theorems – Geodesic parallels – Geodesics curvature- Gauss-Bonnet Theorem – Gaussian curvature – Surface of constant curvature.

UNIT IV: Non Intrinsic Properties of a Surface

The second fundamental form – Principal curvature – Lines of curvature – Developable - Developable associated with space curves and with curves on surface – Minimal surfaces – Ruled surfaces

UNIT V: Differential Geometry of Surfaces

Compact surfaces whose points are umblics – Hilbert's lemma – Compact surface of constant curvature –Complete surface and their Characterization – Hilbert's Theorem – Conjugate points on geodesics.

TEXT BOOK:

T.J. Willmore, *"An Introduction to Differential Geometry"*, Oxford University press, (17th Impression), New Delhi, 2002. (Indian Print)

UNIT	Chapter(s)	Sections
I	I	1 – 9
II	II	1 – 9
III	II	10 – 18

IV	**III**	**1 – 8**
V	**IV**	**1 – 8**

BOOKS FOR SUPPLEMENTARY READING AND REFERENCES:

1. **D.T. Struik**, *"Lectures on Classical Differential Geometry"*, Addition –Wesley, Mass, 1950.
2. **S. Kobayashi and K. Nomizu,** *"Foundations of Differential Geometry",* Interscience Publishers, 1963.
3. **W. Klingenberg,** *"A Course in Differential Geometry*", Graduate Texts in Mathematics, Springer – Verlag 1979.
4. **C.E.Weatherburn**, *"Differential Geometry of Three Dimensions*", University Press, Cambridge, 1930.

16UPMAT1E18	TOPOLOGY - II	CREDITS: 4

UNIT I:

Quotient topology – Imbedding of manifolds – The Tychonoff Theorem – The Stone-Čech compactification.

UNIT II:

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

UNIT III:

Complete metric spaces – A space filling curve – Compactness in metric spaces – Pointwise and Compact convergence – Ascoli theorem.

UNIT IV:

Baire spaces – A nowhere differentiable function – Introduction to dimension theory.

UNIT V

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

TEXT BOOK :

James R. Munkres, *"Topology"*, 2nd Edition, Prentice Hall of India Pvt. Ltd., 2000.

UNIT	Chapter(s)	Sections
I	1, 4 & 5	22, 36 – 38
II	6	39 – 42
III	7	43 – 47
IV	8	48 – 50
V	9	51 – 54

Books for Supplementary Reading and REFERENCES:

1. **J. Dugundji,** *"Topology"*, Prentice Hall of India, New Delhi, 1975.
2. **J.L. Kelly,** "General Topology", Van Nostrand, Reinhold Co., New York, 1991.
3. **K.Janich,** *"Topology"*, Springer-Verlag, New York, 1995 (Translated from the German)

16UPMAT1E19	PARTIAL DIFFERENTIAL EQUATIONS – II	CREDITS: 4

Unit-I:

Introduction: Partial Differential Equations – Classifications – Examples

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: Other ways to represent solutions

Separation of variables - Similarity solutions.

UNIT V: Other ways to represent solutions

Transform methods - Converting nonlinear into linear PDE.

TEXTBOOK:

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

UNIT	Chapter(s)	Sections
I	1 & 2	1.1, 1.2, 2.2
II	2	2.3
III	2	2.4
IV	4	4.1, 4.2
V	4	4.3, 4.4

BOOKS FOR SUPPLEMENTARY READING AND REFERENCES:

1. **D. Colton**, *"Partial Differential Equations: An Introduction",* Dover Publishers, New York, 1988.
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. **R. McOwen,** *"Partial Differential Equations: Methods and Applications*", 2nd Edition, Pearson Education, 2005.

16UPMAT1E20	NONLINEAR DIFFERENTIAL EQUATIONS	CREDITS: 4

UNIT I: Plane autonomous systems and linearization

The general phase plane - Some population models – Linear approximation at equilibrium points – Linear systems in matrix form.

UNIT II: Periodic Solutions and 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: Stability

Poincare stability – Paths and solution curves for general systems - Stability of time solutions: Liapunov stability - Liapunov stability of plane autonomous linear systems

UNIT V: Stability

Structure of the solutions of *n*-dimensional linear systems - Structure of *n*-dimensional inhomogeneous linear systems - Stability and boundedness for linear systems - Stability of linear systems with constant coefficients.

TEXT BOOK:

D.W.Jordan and P.Smith, *"Nonlinear Ordinary Differential Equations"*, 4th Edition, Oxford University Press, New York, 2007.

UNIT	Chapter	Sections
I	2	2.1 – 2.5
II	4	4.1 – 4.5
III	5	5.1 – 5.5, 5.8 – 5.11
IV	8	8.1 – 8.4
V	8	8.5 – 8.8

BOOKS FOR SUPPLEMENTARY READING AND REFERENCES:

1. **G.F. Simmons,** "*Differential Equations"*, Tata McGraw-Hill, New Delhi, 1995.

2. **D.A. Sanchez,** "*Ordinary Differential Equations and Stability Theory"*, Dover, New York, 1979.
3. **J.K. Aggarwal**, "*Notes on Nonlinear Systems"*, Van Nostrand, 1972.

16UPMAT1E21	MATHEMATICAL BIOLOGY	CREDITS: 4

UNIT I: Single Species Population Dynamics

Continuous time models – Growth models, Logistic model – Evolutionary Aspects – Delay models.

UNIT II: Two Species Population Dynamics

The Lotka-Volterra Prey-Predator equations – Modelling the predator functional response Competition – Ecosystems modeling.

UNIT III: Infectious Diseases

Simple epidemic and SIS diseases – SIR Epidemics – SIR Endemics.

UNIT IV: Biochemical Kinetics

Transitions between states at the molecular and populations level – Law of mass action – Enzyme kinetics.

UNIT V: Biochemical Kinetics

Simple models for polymer growth dynamics.

TEXT BOOK:

1. **N. Britton,** "*Essential Mathematical Biology",* Springer Science & Business Media, 2012.
2. **L.A. Segel and L. Edelstein-Keshet,** A Primer in Mathematical Models in Biology, SIAM, Vol. 129, 2013.

UNIT	Chapter/ Text Book	Section(s)
I	1 of [1]	1.3 – 1.5, 1.7
II	2 of [1]	2.3 - 2.6
III	3 of [1]	3.1 - 3.4
IV	2 of [2]	2.1 - 2.4
V	2 of [2]	2.5

BOOKS FOR SUPPLEMENTARY READING AND REFERENCES:

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

2. **A. D. Bazykin,** *"Nonlinear dynamics of interacting populations",* World Scientific, 1998.
3. **J.N.Kapur,** "*Mathematical Models in Biology and Medicine"*, Affiliated East–West, New Delhi, 1985.

16UPMAT1E22	FLUID DYNAMICS	CREDITS: 4

Unit I: INVISCID THEORY

Introductory Notions, velocity: Streamlines and paths of the particles-stream tubes and filaments-fluid body- Density – Pressure – Bernoulli's theorem. Differentiation with respect to time- Equation of continuity- Boundary conditions: kinematical and physical – Rate of change of linear momentum – The equation of motion of an inviscid fluid.

Unit II:

Euler's momentum theorem- conservative forces – Lagrangian form of the equation of motion – Steady motion – The energy equation – Rate of change of circulation – Vortex motion – Permanence of vorticity.

Unit III: TWO DIMENTIONSAL MOTION

Two dimensional functions: Stream function – Velocity potential – Complex potential – Indirect approach – Inverse function. Basic singularities: Source – Doublet – Vortex – Mixed flow – Method of images: Circle theorem – Flow past circular cylinder with circulation. The aerofoil: Blasius's theorem – Lift force.

Unit IV: VISCOUS THEORY

The equations of motion for viscous flow: The stress tensor – The Navier-Stokes equations – Vorticity and circulation in a viscous fluid. Flow between parallel flat plates: Couette flow, Plane Poiseuille flow. Steady flow in pipes: Hagen-Poiseuille flow.

Unit V: BOUNDARY LAYER THEORY

Boundary layer concept- Boundary layer equations in two dimensional flow- Boundary layer along a flat plate: Blasius solution – Shearing stress and boundary layer thickness – Momentum integral theorem for the boundary layer: The von Karman integral relation – von Karman integral relation by momentum law.

TEXT BOOKS:

1. L.M. Milne Thomson, "*Theoretical Hydrodynamics"*, Dover, 1996.

2. **N. Curle and H.J. Davies**, "*Modern Fluid Dynamics Vol-I"* by, D Van Nostrand Company Ltd.,London, 1968.
3. **S.W. Yuan,** *"Foundations of Fluid Mechanics"* by Prentice- Hall of India, New Delhi, 1988.

UNIT	Chapter(s)	Sections
I	I & III of [1]	1.0 – 1.4, 3.10 – 3.31, 3.40, 3.41
II	III of [1]	3.42 – 3.45, 3.50 – 3.53
III	3 of [2]	3.2, 3.3, 3.5 - 3.5.1, 3.5.2, 3.7.4, 3.7.5
IV	5 of [2]	5.2.1- 5.2.3
	8 of [3]	8.3 – a,b, 8.4 – a
V	9 of [3]	9.1, 9.2, 9.3 – a,b, 9.5 – a,b

BOOKS FOR SUPPLEMENTARY READING AND REFERENCES:

1. **R.K. Bansal**, *"An Introduction to Fluid Dynamics",* Firewall Media, 2005.
2. **G.K. Batchelor,** *"An Introduction to Fluid Dynamics",* Cambridge University Press, 2000.
3. **F. Chorlton,** *"Text Book of Fluid Dynamics*", CBS Publications, Delhi, 1985.
4. **D.E. Rutherford**, *"Fluid Dynamics",* Oliver and Boyd, 1959.

16UPMAT1E23	MATLAB	CREDITS: 4

UNIT I:

Starting with Matlab – Creating arrays – Mathematical operations with arrays.

UNIT II:

Script files – Functions and function files.

UNIT III:

Two-dimensional plots – Three-dimensional plots.

UNIT IV:

Programming in MATLAB.

UNIT V:

Polynomials, Curve fitting and interpolation - Applications in numerical analysis.

TEXT BOOK:

A. Gilat, *"MATLAB: An Introduction with Application"* John Wiley & Sons, Singapore, 2004.

UNIT	Chapter(s)
I	1 , 2, 3
II	4, 6
III	5, 9
IV	7
V	8, 10

BOOKS FOR SUPPLEMENTARY READING AND REFERENCES:

1. **D. M. Etter, D. C. Kuncicky and H.Moore,** "*Introduction to MATLAB 7"* Prentice Hall, New Jersy, 2004.
2. **W.J. Palm,** "*Introduction to Matlab 7 for Engineers"* McGrawHill Education, New York, 2005.

3. **R. Pratap,** "*Getting Started with MATLAB – A Quick Introduction for Scientists and Engineers",* Oxford University Press, New Delhi, 2006.

16UPMAT1S01	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.

TEXT BOOK:

1. **B.S. Grewal,** *"Higher Engineering Mathematics*", 30th Eighth Edition, Khanna Publishers, Delhi, 2004.
2. **E. Kreyszig,** *"Advanced Engineering Mathematics"*, 8th Edition, John Wiley and Sons, (Asia), Singapore, 2000.

16UPMAT1S02	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 solenoid 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 – Esler's method – Modified Euler method, Runge-Kutta Method – Solving simultaneous equations.

TEXT BOOK:

1. **E. Kreyszig,** *"Advanced Engineering Mathematics"*, 8th Edition, John Wiley and Sons, Singapore, 2000.
2. **B.S. Grewal,** *"Higher Engineering Mathematics*", 30th Edition, Khanna Publishers, Delhi 2004.

16UPMAT1S03	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.C. Gupta** and **V.K. Kapoor,** *"Fundamentals of Mathematical Statistics*", Sultan Chand & Sons, 1994.
2. **P. Kandasamy, K. Thilagavathy, K. Gunavathi**, *"Numerical Methods*", 3rd Edition, S. Chand, 2006.

BOOKS FOR SUPPLEMENTARY READING AND REFERENCES:

1. **S.Kalavathy**, *"Numerical Methods*", Vijay Nicole, Chennai, 2004.
2. **S.S. Sastry**, *"Introductory Methods of Numerical Analysis*", Prentice Hall of India, Pvt Ltd., 1995.

16UPMAT1S04	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"*, S. Chand & Sons, New Delhi, 1994.

BOOKS FOR SUPPLEMENTARY READING AND REFERENCES:

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

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