GURU NANAK COLLEGE (AUTONOMOUS)

VELACHERY ROAD, CHENNAI – 600042

(Re-accredited at 'A-Grade' by NAAC) Affiliated to University of Madras

MASTER OF SCIENCE (MATHEMATICS)

(SEMESTER PATTERN WITH CHOICE BASED CREDIT SYSTEM)

SYLLABUS

(For the candidates admitted for the Academic year 2020 - 21 and onwards)

VISION

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

MISSION

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

PROGRAMME OUTCOMES

PO 1: Develop specific knowledge in main subfields of pure and applied mathematics to apply them independently to solve problems of real-life situations.

PO 2: Demonstrate an understanding of Abstract Algebra, Analysis, Differential, Difference Equations, Topology, Geometry, Graphs, Fuzzy Sets, Statistics, Stochastic Processes, Mechanics, Number Theory, Calculus of Variations & Integral Equations, Programming in C++ and Operations Research.

PO 3: Demonstrate skills in analyzing concepts and solving given problems at a high level of abstraction.

PO 4: Inculcate scientific knowledge in varying research areas of core and elective subjects through the curriculum where the summer internship is being a part.

PO 5: Create ability to apply mathematical methodologies in various sectors like banking, IT,TNPSC, UPSC, etc.

PROGRAMME SPECIFIC OUTCOMES

PSO 1: Establish knowledge of the basics as well as advanced level in each core subject through extra classes too, whenever needed, which make students of different performing levels, age categories learn with ease and compete with each other.

PSO 2: Generate students as motivated Teachers in Schools & Colleges as Researchers and as successful professionals in the various other fields by providing one to one interactions with the students to develop their skills in curricular & co-curricular activities.

M.Sc. MATHMEMATICS
COURSE STRUCTURE 2019-2021 BATCH

Semester	Part	Course Component	Subject Code	Subject Name	Credits	Hours	Internal	External	Total
Semester - I	III	Core-1	19PMAT301	Algebra-I	4	5	50	50	100
	III	Core-2	19PMAT302	Real Analysis-I	4	6	50	50	100
	III	Core-3	19PMAT303	Ordinary Differential Equations	4	6	50	50	100
	III	Core-4	19PMAT304	Graph Theory	4	6	50	50	100
	III	Elective-1	19PMAT305	Fuzzy sets and their Applications	3	5	50	50	100
	IV	Soft skill-1	19PGSL401A	Personality Enrichment	2	2	50	50	100
Total Credits: 21 / Total Hours per week: 30									
Semester - II	III	Core-5	19PMAT306	Algebra-II	4	5	50	50	100
	III	Core-6	19PMAT307	Real Analysis-II	4	6	50	50	100
	III	Core-7	19PMAT308	Partial Differential Equations	4	6	50	50	100
	III	Core-8	19PMAT309	Probability Theory	4	5	50	50	100
	III	Extra Disciplinary-1	19PMAT310	Object Oriented Programming with C++	3	3	50	50	100
	III	Extra Disciplinary-2	19PMAT311P	Practical for Programming with C++	3	3	50	50	100
	IV	Soft skill-2	19PGSL402D	Computing Skill	2	2	50	50	100
Total Credits: 25 / Total Hours per week: 30									
Semester – III	III	Core-9	19PMAT312	Complex Analysis –I	4	5	50	50	100
	III	Core-10	19PMAT313	Topology	4	5	50	50	100
	III	Core-11	19PMAT314	Operations Research	4	5	50	50	100
	III	Core-12	19PMAT315	Mechanics	4	5	50	50	100
	III	Elective-2	19PMAT316	Difference Equations	3	3	50	50	100
	III	Elective-3	19PMAT317	Number theory and Cryptography	3	5	50	50	100
	IV	Soft skill-3	19PGSL403G	Self and Time Management Skill	2	2	50	50	100
	IV		19PINT401	Summer Internship	2	-	-	-	-
Total Credits: 26 / Total Hours per week: 30									

M.Sc. MATHMEMATICS
COURSE STRUCTURE 2019-2021 BATCH

Semester	Part	Course Component	Subject Code	Subject Name	Credits	Hours	Internal	External	Total
Semester - IV	III	Core-13	19PMAT318	Complex Analysis-II	4	6	50	50	100
	III	Core-14	19PMAT319	Differential Geometry	4	6	50	50	100
	III	Core-15	19PMAT320	Functional Analysis	4	6	50	50	100
	III	Elective-4	19PMAT321	Calculus of Variations and Integral Equations	3	5	50	50	100
	III	Elective-5	19PMAT322	Stochastic Processes	3	5	50	50	100
	IV	Soft skill-4	19PGSL404E	Spoken and Presentation Skill	2	2	50	50	100
Total Credits: 20 / Total Hours per week: 30									

CORE - I
COURSE TITLE: ALGEBRA – I

SUBJECT CODE :19PMAT301	**THEORY**	**100 MARKS**
SEMESTER: I	**CREDITS: 4**	**TOTAL HOURS: 75**

COURSE OBJECTIVE:

- To develop the basic knowledge in algebraic structures

UNIT-I **(15hrs)**

Another counting principle, Sylow theorems - Applications of Sylow theorems.
Recommended Chapter 2: Section 2.11 and 2.12 of I.N. Herstein

UNIT-II **(15hrs)**

Direct products: Internal direct product, External direct product, Finite abeliangroups :Invariants of groups, Modules : Direct sum of modules, cyclic module, finitely generated module.
Recommended Chapter 2: Sections 2.13 and 2.14,
Chapter 4: Section 4.5 of I.N. Herstein

UNIT-III **(15hrs)**

Linear Transformations - Canonical forms-Triangular form: Similar Transformation, Invariant under Linear Transformations – Nilpotent transformations.
Recommended Chapter 6: Sections 6.4 , 6.5 of I.N. Herstein

UNIT-IV **(15hrs)**

Jordan form - rational canonical form: companion matrix of f(x).
Recommended Chapter6: Sections 6.6 and 6.7 of I.N. Herstein

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

Trace and transpose - Hermitian, unitary, normal transformations, real quadratic form.
Recommended Chapter 6 : Sections 6.8, 6.10 and 6.11 (Omit6.9) of I.N. Herstein

PRESCRIBED BOOK:

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

REFERENCE BOOKS:

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

QUESTION PAPER PATTERN:

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

DISTRIBUTION OF QUESTIONS:

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

CORE -II
COURSE TITLE: REAL ANALYSIS –I

SUBJECT CODE: 19PMAT302	**THEORY**	**100 MARKS**
SEMESTER: I	**CREDITS: 4**	**TOTAL HOURS: 90**

COURSE OBJECTIVE:

- To understand the basic knowledge in real analysis

UNIT-I **(18 hrs)**

Functions of bounded variation - Introduction - Properties of monotonic functions - Functions of bounded variation - Total variation - Additive property of total variation - Total variation on [a, x] as a function of x - Functions of bounded variation expressed as the difference of two increasing functions - Continuous functions of bounded variation.

Recommended Chapter 6: Sections 6.1 to 6.8 of Tom M. Apostol

Infinite Series: Absolute and conditional convergence - Dirichlet's test and Abel's test.

Recommended Chapter 8 : Sections 8.8, 8.15 of Tom M. Apostol

UNIT-II **(18 hrs)**

The Riemann - Stieltjes Integral - Introduction - Notation - The definition of the Riemann - Stieltjes integral - Linear Properties - Integration by parts- Change of variable in a Riemann - Stieltjes integral - Reduction to a Riemann Integral – Euler's summation formula - Monotonically increasing integrators, Upper and lower integrals - Additive and linearity properties of upper and lower integrals - Riemann's condition - Comparison theorems.Recommended Chapter 7: Sections 7.1 to 7.14of Tom M. Apostol

UNIT-III **(18 hrs)**

The Riemann-Stieltjes Integral - Integrators of bounded variation-Sufficient conditions for the existence of Riemann-Stieltjes integrals-Necessary conditions for the existence of Riemann-Stieltjes integrals- Mean value theorems for Riemann- Stieltjes integrals - The integrals as a function of the interval - Second fundamental theorem of integral calculus-Change of variable in a Riemann integral-Second Mean Value Theorem for Riemann integral-Riemann-Stieltjes integrals depending on a parameter-Differentiation under the integral sign- Lebesguecriteriaon for the existence of Riemann integrals.Recommended Chapter - 7: 7.15 to 7.24, 7.26 ofTom M. Apostol

UNIT-IV **(18 hrs)**

Infinite Series and infinite Products-Multiplication of series–Cesarosummability-Infinite products.Power series - Multiplication of power series - The Taylor's series generated by a function - Bernstein's theorem - Abel's limit theorem - Tauber's theorem

Recommended Chapter 8: Sec, 8.24 to 8.26

Recommended Chapter 9: Sections 9.14, 9.15, 9.19, 9.20, 9.22, 9.23 of Tom M. Apostol

UNIT-V **(18 hrs)**

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

Recommended Chapter 9: Sec 9.1 to 9.6, 9.8, 9.9, 9.10, 9.11 of Tom M. Apostol

PRESCRIBED BOOK:

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

REFERENCE BOOKS:

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

QUESTION PAPER PATTERN:

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

DISTRIBUTION OF QUESTIONS:

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

CORE - III
COURSE TITLE: ORDINARY DIFFERENTIAL EQUATIONS

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

COURSE OBJECTIVE:

- To understand the problem-solving technique using differential equations.

UNIT-I **(18 hrs)**

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

Recommended Chapter 2: Sections 1 to 6 of E.A.Coddington

UNIT-II **(18 hrs)**

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

Chapter 2 : Sections 7 to 11.

UNIT-III **(18 hrs)**

Linear equation with variable coefficientsInitial value problems -Existence anduniqueness theorems – Solutions to solve a non- homogeneous equation – Wronskianand linear dependence– Reduction of the order of a homogeneous equation –Homogeneous equation with analytic coefficients-The Legendre equation.

Recommended Chapter: 3 Sections 1 to 8(omit section 9) of E. A. Coddington

UNIT-IV **(18 hrs)**

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

Recommended Chapter 4: Sections 3, 4 and 6 to 8 (omit sections 5 and 9) of E. A. Coddington.

UNIT-V **(18 hrs)**

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

Recommended Chapter 5: Sections 1 to 6 (omit Sections 7 to 9) of E. A. Coddington

PRESCRIBED BOOK:

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

REFERENCE BOOKS:

1.Williams E. Boyce and Richard C. Di Prima, Elementary differential equations andboundary value problems,John Wiley and sons, New York, 1967.

2.George F Simmons, Differential equations with applications and historical notes, Tata McGraw Hill, New Delhi, 1974.

3.N.N. Lebedev, Special functions and their applications, Prentice Hall of India, New Delhi, 1965.

4. W. T. Reid. Ordinary Differential Equations, John Wiley and Sons, New York, 1971

5. M. D. Raisinghania, Advanced Differential Equations,S. Chand& Company Ltd. New Delhi 2001.

QUESTION PAPER PATTERN:

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

DISTRIBUTION OF QUESTIONS:

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

CORE -IV
COURSE TITLE: GRAPH THEORY

SUBJECT CODE :19PMAT304	**THEORY**	**100 MARKS**
SEMESTER: I	**CREDITS: 4**	**TOTAL HOURS: 90**

COURSE OBJECTIVE:

- To understand the basic concepts in discrete mathematics

UNIT-I **(18 hrs)**

Graphs, subgraphs and Trees :Graphs and simple graphs–Graph Isomorphism – The Incidence and Adjacency Matrices – Subgraphs – Vertex Degrees – Paths and Connection– Cycles.
Recommended Chapter 1:(Sec 1.1 – 1.7)of J. A. Bondy and U.S.R. Murty Omit Sec.:1.8,1.9

UNIT-II **(18 hrs)**

Cut Vertex and Connectivity: Trees – Cut Edges and Bondy-Cut Vertices– Connectivity - Blocks.
Recommended Chapter 2:(Section 2.1 - 2.3) and Chapter 3 (Section 3.1 – 3.2) ofJ.A.Bondy and U.S.R. Murty . Omit Sections 2.4 & 2.5, Omit Sections 3.3

UNIT-III **(18 hrs)**

Euler Tours, Hamilton Cycles and Edge Colourings: Euler Tours, Hamilton Cycles, Edge Chromatic Number
Recommended Chapter 4: (Section 4.1 – 4.2) and Chapter 6 (Section 6.1) of J.A.Bondy and U.S.R. Murty .Omit Sections 4.3 & 4.4, Omit Sections 6.2 & 6.3

UNIT-IV **(18 hrs)**

Independent sets and Cliques, Vertex Colourings : Independent sets – Ramsey's Theorem – Chromatic Number – Brooks' Theorem – Chromatic Polynomials.
Recommended Chapter 7: (Section 7.1 – 7.2) and Chapter 8 (Section 8.1 – 8.2, 8.4) ofJ.A.Bondy and U.S.R. Murty. Omit Sections 7.3, 7.4 & 7.5, Omit Sections 8.3, 8.5 & 8.6

UNIT-V **(18 hrs)**

Planar graphs : Plane and planar Graphs – Dual graphs – Euler's Formula – The Five- Colour Theorem and the Four-Colour Conjecture.
Recommended Chapter 9: (Section 9.1 – 9.3, 9.6) of J.A.Bondy and U.S.R. Murty Omit Sections 9.4, 9.5, 9.7 & 9.8

PRESCRIBED BOOK:

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

REFERENCE BOOKS:

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

QUESTION PAPER PATTERN:

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

DISTRIBUTION OF QUESTIONS:

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

ELECTIVE -I
COURSE TITLE: FUZZY SETS AND THEIR APPLICATIONS

SUBJECT CODE :19PMAT305	**THEORY**	**100 MARKS**
SEMESTER: I	**CREDITS: 3**	**TOTAL HOURS: 75**

COURSE OBJECTIVE:

- To develop the logical concepts in fuzzy analysis

UNIT-I **(15hrs)**

Fundamental Notions: Review of the notion of membership, The concept of a fuzzy subset, Dominance relations, Simple operations on fuzzy subsets, Set of fuzzy subsets for E and M finite, Properties of the set of fuzzy subsets, Product and algebraic sum of two fuzzy subsets.
Recommended Chapter 1: Sec. 1 to 8 of A. Kaufman

UNIT-II **(15hrs)**

Fuzzy Graphs: Fuzzy relations, composition of Fuzzy relations, Fuzzy subsets induced by a mapping, conditioned Fuzzy subsets, Properties of Fuzzy binary relations, Transitive closure of a Fuzzy binary relations, Paths in a finite Fuzzy graphs.
Recommended Chapter 2: Sec. 10 to 18 of A. Kaufman

UNIT-III **(15hrs)**

Fuzzy Relations: Fuzzy preorder relations, Similitude relations, Similitude subrelations in a fuzzy preorder, Antisymmetry, Fuzzy order relations, Antisymmetric relations without loops. Ordinal relations. Ordinal functions in a fuzzy order relation, Dissimilitude relations, Resemblance relations, Various properties of similitude and resemblance, Various properties of fuzzy perfect order relations.
Recommended Chapter 2: Sec. 19 to 29 of A. Kaufman

UNIT-IV **(15hrs)**

Fuzzy Logic: Characteristic function of a fuzzy subset. Fuzzy variables, Polynomial forms, Analysis of a function of fuzzy variables. Method of Marinos, Logical structure of a function of fuzzy variables, Composition of intervals, Fuzzy propositions and their functional representations, The theory of fuzzy subsets and the theory of probability.
Recommended Chapter 3: Sec.31 to 40 (omit Sec. 37, 38, 41) of A. Kaufman

UNIT-V **(15hrs)**

The Laws of Fuzzy Composition: Review of the notion of a law of composition, Laws of fuzzy internal composition. Fuzzy groupoids, Principal properties of fuzzy groupoids, Fuzzy monoids, Fuzzy external composition, Operations on fuzzy numbers.
Recommended Chapter 4: Sec.43 to 49 of A. Kaufman

PRESCRIBED BOOK:

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

REFERENCE BOOKS:

1. H. J. Zimmermann, Fuzzy Set Theory and its Applications, Allied Publishers, Chennai, 1996
2. George J. Klir and Bo Yuan, Fuzzy sets and Fuzzy Logic-Theory and Applications, Prentice Hall India, New Delhi, 2001.

QUESTION PAPER PATTERN:

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

DISTRIBUTION OF QUESTIONS:

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

CORE -V
COURSE TITLE: ALGEBRA – II

SUBJECT CODE :19PMAT306	**THEORY**	**100 MARKS**
SEMESTER: II	**CREDITS: 4**	**TOTAL HOURS: 75**

COURSE OBJECTIVE:

- To analyse the concepts in extension field.

UNIT-I **(15hrs)**

Extension fields: Degree of extension fields, algebraic element, algebraic extension - Transcendence ofe.Recommended Chapter 5: Section 5.1 and 5.2 of I. N. Herstein

UNIT-II **(15hrs)**

Roots of Polynomials: Simple roots, multiplicity roots, Splitting field- More about roots: derivative of f(x), simple extension
Recommended Chapter 5: Sections 5.3 and 5.5 of I. N. Herstein

UNIT-III **(15hrs)**

Elements of Galois theory: Fixed field, Group of automorphisms relative to field, Splitting field of the polynomials, Normal extension of field, Galois group.
Recommended Chapter 5: Section 5.6 of I. N. Herstein

UNIT-IV **(15hrs)**

Finite fields - Wedderburn's theorem on finite division rings
Recommended Chapter 7: Sections 7.1 and 7.2 (Theorem 7.2.1 only) of I. N. Herstein

UNIT-V **(15hrs)**

Solvability by radicals–Galois groups over the rational –A theorem On Frobenius.
Recommended Chapter 5: Sections 5.7 and 5.8Chapter 7: Sections 7.3 of I. N. Herstein

PRESCRIBED BOOK:

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

REFERENCE BOOKS:

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

QUESTION PAPER PATTERN:

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

DISTRIBUTION OF QUESTIONS:

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

CORE -VI
COURSE TITLE: REAL ANALYSIS – II

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

COURSE OBJECTIVE:

- To analyse the concepts in extended real numbers.

UNIT-I **(18 hrs)**

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

Recommended Chapter 2: Sec 2.1 to 2.5 of de Barra

UNIT-II **(18 hrs)**

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

Recommended Chapter 3: Sec 3.1,3.2 and 3.4 of de Barra

UNIT-III **(18 hrs)**

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

Recommended Chapter 11: Sections 11.1 to 11.15 of Apostol

UNIT-IV **(18 hrs)**

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

Recommended Chapter 12: Section 12.1 to 12.14 of Apostol

UNIT-V **(18 hrs)**

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

Recommended Chapter 13 : Sections 13.1 to 13.7 of Apostol

PRESCRIBED BOOKS:

1. G. de Barra, Measure Theory and Integration, New Age International, 2003 (for Units I and II)
2. Tom M. Apostol : Mathematical Analysis, 2nd Edition, Narosa 1989 (for Units III, IV and V)

REFERENCE BOOKS:

1. Burkill,J.C. The Lebesgue Integral, Cambridge University Press, 1951.
2. Munroe,M.E. Measure and Integration. Addison-Wesley, Mass.1971.

3. Royden,H.L.Real Analysis, Macmillan Pub. Company, New York, 1988.
4. Rudin, W. Principles of Mathematical Analysis, McGraw Hill Company, New York, 1979.
5. Malik,S.C. and SavitaArora. Mathematical Analysis, Wiley Eastern Limited. New Delhi, 1991.

QUESTION PAPER PATTERN:

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

DISTRIBUTION OF QUESTIONS:

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

CORE -VII
COURSE TITLE: PARTIAL DIFFERENTIAL EQUATIONS

SUBJECT CODE :19PMAT308	**THEORY**	**100 MARKS**
SEMESTER: II	**CREDITS: 4**	**TOTAL HOURS: 90**

COURSE OBJECTIVE:

- To develop the problem-solving technique using Partial Differential Equations.

UNIT-I **(18 hrs)**

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

Recommended Chapter 1: Section: 1.1 to 1.3 of K. SankaraRao

UNIT-II **(18 hrs)**

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

Recommended Chapter 2:Section: 2.1 to 2.3, 2.5 to 2.11of K. SankaraRao

UNIT-III **(18 hrs)**

Parabolic Differential Equations: Occurrence of The Diffusion Equation –Boundary Conditions – Elementary Solutions of the Diffusion Equation – Dirac Delta Function – Separation of Variables Method – Solution of diffusion equation in cylindrical coordinates.

Recommended Chapter 3:Section: 3.1 to 3.6 of K. SankaraRao

UNIT-IV **(18 hrs)**

Hyperbolic Differential Equations: Occurrence of the Wave Equation – Derivation of One-dimensional Wave Equation – Solution of One-dimensional Wave Equation by Canonical Reduction – The Initial Value Problem; D'Alembert's Solution – Vibrating String: Variables Separable Solution - Forced Vibrations: Solution of Non- homogeneous Equation – Boundary and Initial Value Problem for Two-dimensionalWaveEquations:Method of Eigenfunction.

Recommended Chapter 4:Section: 4.1 to 4.7 of K. SankaraRao

UNIT-V **(18 hrs)**

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

Recommended Chapter 5:Section: 5.1.to 5.6. of K. SankaraRao

PRESCRIBED BOOK:

Introduction to Partial Differential Equations" by K. SankaraRao , Third Edition, PHI Learning Private Limited.

REFERENCE BOOKS:

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

QUESTION PAPER PATTERN:

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

DISTRIBUTION OF QUESTIONS:

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

CORE -VIII
COURSE TITLE: PROBABILITY THEORY

SUBJECT CODE:19PMAT309	**THEORY**	**100 MARKS**
SEMESTER: II	**CREDITS: 4**	**TOTAL HOURS: 75**

COURSE OBJECTIVE:

- An elaborate study in probability theory.

UNIT-I **(15hrs)**

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.

Recommended Chapter 1: Sections 1.1 to 1.7Chapter 2 : Sections 2.1 to 2.9 of M. Fisz

UNIT-II **(15hrs)**

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

Recommended Chapter 3:Sections 3.1 to 3.8 of M. Fisz

UNIT-III **(15hrs)**

Characteristic functions: Properties of characteristic functions – Characteristic functions and moments – semi0invariants – 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.

Recommended Chapter 4: Sections 4.1 to 4.7 of M. Fisz

UNIT-IV **(15hrs)**

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

Recommended Chapter 5: Section 5.1 to 5.10 (Omit Section 5.11) of M. Fisz

UNIT-V **(15hrs)**

Limit Theorems: Stochastic convergence – Bernoulli 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 – LapunovTheroem – Borel-Cantelli Lemma – Kolmogorov Inequality and Kolmogorov Strong Law of large numbers.Recommended Chapter 6 : Sections 6.1 to 6.4, 6.6 to 6.9 , 6.11 and6.12. (Omit Sections 6.5, 6.10,6.13 to 6.15) ofM. Fisz

PRESCRIBED BOOK:

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

REFERENCE BOOKS:

1. R.B. Ash, Real Analysis and Probability, Academic Press, New York, 1972
2. K.L.Chung, A course in Probability, Academic Press, New York, 1974.
3. R.Durrett, Probability : Theory and Examples, (2nd Edition) Duxbury Press, New York, 1996.

4. V.K.Rohatgi, An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern Ltd., New Delhi, 1988(3rd Print).
5. S.I.Resnick, A Probability Path, Birhauser, Berlin,1999.
6. B.R.Bhat , Modern Probability Theory (3rd Edition), New Age International (P)Ltd, New Delhi, 1999.

QUESTION PAPER PATTERN:

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

DISTRIBUTION OF QUESTIONS:

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

EXTRA DISCIPLINARY- I
COURSE TITLE: OBJECT ORIENTED PROGRAMMING WITH C++

SUBJECT CODE:19PMAT310	**THEORY**	**100 MARKS**
SEMESTER: II	**CREDITS: 3**	**TOTAL HOURS: 45**

COURSE OBJECTIVE:

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

UNIT-I **(9hrs)**

Basic concepts of object-oriented programming –Structure of C++ Program. Variables – Operators – Manipulators – Expressions and their types – Control Structures – Functions – Main Function – Function Prototyping– Default Arguments – Function Overloading.

Recommended Chapter1:Section 1.5, Chapter 2:Section 2.6, Chapter3: Sections3.12,3.13,3.17,3.19,3.24 and Chapter 4:Sections 4.2,4.3,4.7,4.9 of (Balagurusamy)

UNIT-II **(9hrs)**

Classes and Objects – Specifying a Class – Defining Member Functions – A C++Program with Class – Static Members – Arrays of Objects – Objects as FunctionArguments – FriendFunctions – Returning Objects.

Recommended Chapter5:Sections5.3,5.4,5.5,5.11,5.12,5.13,5.14, 5.15, 5.16 of (Balagurusamy)

UNIT-III **(9hrs)**

Constructors and Destructors – Parameterized Constructors – Multiple Constructors in a Class – Copy constructors – Destructors – Defining Operator Overloading – Overloading Unary Operators – Overloading Binary Operators – Using Friend Function – Rules for Overloading Operators

Recommended Chapter6: Sections 6.3, 6.4, 6.7, 6.11 and Chapter 7:Sections7.2, 7.3, 7.4, 7.5, 7.7 of (Balagurusamy)

UNIT-IV **(9hrs)**

Inheritance – Defining Derived Classes – Single Inheritance – Multilevel Inheritance – Multiple inheritance – Virtual Base Classes – Pointers to Objects – this pointer – Pointer to Derived Classes – virtual Functions and Polymorphism – Pure Virtual Function

Recommended Chapter8: Sections 8.2, 8.3, 8.5, 8.6, 8.9 and Chapter9:Sections9.3, 9.4, 9.5, 9.6, 9.7 of (Balagurusamy)

UNIT-V **(9hrs)**

Managing Console I/O Operations – C++ Streams – C++ Stream Classes —– Working with Files – Classes for File Stream Operations – Opening and Closing a File – Detecting End – of File – File Modes.

Recommended Chapter5: Sections 5.3, 5.4, 5.5, 5.11, 5.12, 5.13, 5.14, 5.15, 5.16 of (Balagurusamy)

PRESCRIBED BOOK:

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

REFERENCE BOOK:

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

QUESTION PAPER PATTERN:

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

DISTRIBUTION OF QUESTIONS:

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

EXTRA DISCIPLINARY- II
COURSE TITLE: PRACTICAL FOR PROGRAMMING WITH C++

SUBJECT CODE :19PMAT311P	**PRACTICAL**	**100 MARKS**
SEMESTER: II	**CREDITS: 3**	**TOTAL HOURS:45**

COURSE OBJECTIVES:

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

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

QUESTION PAPER PATTERN:

Section	Question Component	Numbers	Marks	Total
Section A	Write any 2 out of 4 programs	1 – 10	50	100
TOTAL MARKS				100

CORE -IX
COURSE TITLE: COMPLEX ANALYSIS – I

SUBJECT CODE:19PMAT312	**THEORY**	**100 MARKS**
SEMESTER: III	**CREDITS: 4**	**TOTAL HOURS: 75**

COURSE OBJECTIVE:

- An elaborate study in complex analysis.

UNIT-I **(15hrs)**

Cauchy's Integral Formula:
The Index of a point with respectto a closed curve - The Integral formula - Higher derivatives. Local Properties of Analytical Functions: Removable Singularities-Taylors's Theorem-Zeros and poles-The local Mapping - The Maximum Principle .
Recommended Chapter 4 : Section 2 : 2.1 to 2.3, Section 3 :3.1 to 3.4
of Lars V. Ahlfors

UNIT-II **(15hrs)**

The general form of Cauchy's Theorem:Chains and cycles- Simple Connectivity -Homology - The General statement of Cauchy's Theorem - Proof of Cauchy's theorem – Locally exact differentials-Multiply connected regions – Residue theorem - The argument principle.
Recommended Chapter 4 : Section 4 : 4.1 to 4.7, Section 5: 5.1 and 5.2ofLars V. Ahlfors

UNIT-III **(15hrs)**

Evaluation of Definite Integrals and Harmonic Functions:
Evaluation of definite integrals - Definition of Harmonic functions and basic properties - Mean value property - Poisson formula.
Recommended Chapter 4: Section 5: 5.3, Section: 6.1 to 6.3ofLars V. Ahlfors

UNIT-IV **(15hrs)**

Harmonic Functions and Power Series Expansions: Schwarz theorem - The reflection principle - Weierstrass theorem - Taylor Series - Laurent series.
Recommended Chapter 4 : Sections 6.4 and 6.5 Chapter 5 : Sections 1.1 to 1.3
OfLars V. Ahlfors

UNIT-V **(15hrs)**

Partial Fractions and Entire Functions:
Partial fractions–Infinite products - Canonical products - Gamma Function -Jensen's formula
Recommended Chapter 5: Sections 2.1 to 2.4, Section 3.1of Lars V. Ahlfors

PRESCRIBED BOOK:

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

REFERENCE BOOKS

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

QUESTION PAPER PATTERN:

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

DISTRIBUTION OF QUESTIONS:

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

CORE -X
COURSE TITLE: TOPOLOGY

SUBJECT CODE :19PMAT313	**THEORY**	**100 MARKS**
SEMESTER: III	**CREDITS: 4**	**TOTAL HOURS: 75**

COURSE OBJECTIVE:

- To read understand and develop the dynamic in topology.

UNIT-I **(15hrs)**

Topological spaces, Basis for a topology, Product topology on X x Y, Subspace topology, Closed sets and Limit points, Continuous functions.
Recommended Chapter 2: Sections 12, 13, 15, 16, 17, 18.
of James R. Munkres

UNIT-II **(15hrs)**

Connected spaces, Connected subspaces of the real line, Components and Localconnectedness, Compact spaces, Compact subspaces of the real line.
Recommended Chapter 3: Sections 23, 24, 25, 26, 27.of James R. Munkres

UNIT-III **(15hrs)**

Countability axioms, Separation axioms, Normal spaces, UrysohnLemma, Urysohnmetrization theorem, Tietze extension theorem.
Recommended Chapter 4: Sections 30, 31, 32, 33, 34, 35.of James R. Munkre

UNIT-IV **(15hrs)**

Product topology: J-tuple of elements, Cartesian product, box topology, product topology, Tychonoff theorem.Recommended Chapter 2: Sections 19.ofJames R. Munkres Chapter 5 - Section 37.

UNIT-V **(15hrs)**

Homotopy of paths: homotopic, null homotopic, path homotopic, product of two paths, Fundamental group: loop, fundamental group, simply connected set, homomorphism induced by a map.
Recommended Chapter 9: Sections 51, 52. Of James R.Munkres

PRESCRIBED BOOK:

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

REFERENCE BOOKS

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

QUESTION PAPER PATTERN:

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

DISTRIBUTION OF QUESTIONS:

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

CORE -XI
COURSE TITLE: OPERATIONS RESEARCH

SUBJECT CODE :19PMAT314	**THEORY**	**100 MARKS**
SEMESTER: III	**CREDITS: 4**	**TOTAL HOURS:75**

COURSE OBJECTIVE:

- To find the solution in optimization problems.

UNIT-I **(15hrs)**

Integer Programming: Illustrative Applications- Integer programming algorithm – Branch and Bound algorithm – Cutting plane algorithm.
Recommended Chapter 9: sec. 9.1 and 9.2.

UNIT-II **(15hrs)**

Dynamic Programming: Recursive nature of computation in DP – Forward and Backward recursion. Selected DP application – Cargo Loading model – Work force size model – problem of dimensionality.
Recommended Chapter 12: Sections 12.1, 12.2, 12.3: 12.3.1, 12.3.2, 12.4.

UNIT-III **(15 hrs)**

Deterministic Inventory Control Models: General inventory model – static EOQ model – classical EOQ model – EOQ with price breaks – multi item EOQ with storage limitation.
Recommended Chapter 13: Sec. 13.1 and 13.3

UNIT-IV **(15hrs)**

Queueing Systems: Elements of a queueing model – Specialized Poisson Queues – Steady state measures of performance – Single server models – Multiple server models.
Recommended Chapter 18: Sec. 18.2, 18.6: 18.6.1, 18.6.2, 18.6.3.

UNIT-V **(15hrs)**

Nonlinear programming algorithm: Unconstrained algorithm – Direct search method – Gradient method – Constrained algorithm – Separable programming – Quadratic programming.
Recommended Chapter 21: Sec. 21.1, 21.2: 21.2.1, and 21.2.2.

PRESCRIBED BOOK:

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

REFERENCE BOOKS

1. F.S. Hiller and J.Lieberman -,Introduction to Operations Research (7th Edition), Tata McGraw Hill Publishing Company, New Delhi, 2001.
2. Beightler. C, D.Phillips, B. Wilde ,Foundations of Optimization (2nd Edition) Prentice Hall Pvt Ltd., New York, 1979
3. Bazaraa, M.S; J.J.Jarvis, H.D.Sharall, Linear Programming and Network flow, John Wiley and sons, New York 1990.
4. Gross, D and C.M.Harris, Fundamentals of Queueing Theory, (3rd Edition), Wiley and Sons, New York, 1998.

QUESTION PAPER PATTERN:

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

DISTRIBUTION OF QUESTIONS:

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

CORE -XII
COURSE TITLE: MECHANICS

SUBJECT CODE 19PMAT315	**THEORY**	**100 MARKS**
SEMESTER: III	**CREDITS: 4**	**TOTAL HOURS: 75**

COURSE OBJECTIVE:

- To find the mathematical models in mechanical system.

UNIT-I **(15hrs)**

Mechanical Systems: The Mechanical system- Equations of motion, Units. Generalised coordinates – Degrees of freedom, Generalised coordinates, configuration space. Constraints – Holonomic constraints, non-holonomic constraints, Unilateral constraints. Virtual work – Virtual displacement, Virtual work, principle of virtual work, D'Alembert's principle, Generalised force. Energy and Momentum - Potential energy, work and kinetic energy, conservation of energy, equilibrium and stability, kinetic energy of a system, angular momentum, Generalised momentum.
Recommended Chapter 1: Sections 1.1 to 1.5 of D.Greenwood.

UNIT-II **(15hrs)**

Lagrange's Equations: Derivation of Lagrange's equations- Kinetic energy, Lagrange's Equations, Form of the equations of motion, non-holonomic systems. Examples- Spherical pendulum, Double pendulum, Lagrange multipliers and constraint forces, Particle in whirling tube, particle with moving support, rheonomic constrained system. Integrals of motion- Ignorable coordinates,Example-the Kepler problem. Routhian function, conservative systems, Natural systems, Liouville's system.
Recommended Chapter 2 : Sections 2.1 to 2.3 (Omit Section 2.4) of D. Greenwood

UNIT-III **(15hrs)**

Hamilton's Equations: Hamilton's Principle – Stationary values of a function, constrained stationary values, stationary value of a definite integral. Examples – geodesic path, case of n dependent variables, Hamilton's principle, non holonomic systems, multiplier rule. Hamilton's Equation – Derivation of Hamilton's equations, the form of the Hamiltonian function, Legendre transformation.
Other variation AL principles – Modified Hamiltons principle, principle of least action.
Recommended Chapter 4 : Sections 4.1 to 4.3 (Omit section 4.4) of D. Greenwood

UNIT – IV **(15hrs)**

Hamilton-Jacobi Theory: Hamilton Principle function – The canonical integral, Ptaffian differential forms. Hamilton-Jacobi Equation
Recommended Chapter 5 : Sections 5.1 to 5.2of D. Greenwood

UNIT-V **(15hrs)**

Canonical Transformation: Differential forms and generating functions - canonical transformations, principal forms of generating functions, Further comments on the Hamilton- Jacobi method. Special Transformations– some special transformations, Homogeneous canonical transformations, point transformations, momentum transformations. Lagrange and Poisson brackets- Legendre brackets, Poisson brackets, The bilinear covariant.
Recommended Chapter 6 : Sections 6.1, 6.2 and 6.3 (omit sections 6.4, 6.5 and 6.6) of D. Greenwood

PRESCRIBED BOOK:

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

REFERENCE BOOKS:

1. H. Goldstein, Classical Mechanics, (2nd Edition) NarosaPublishing 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 (3rdEdition) McGraw Hill Book Co., New York, 1970.

QUESTION PAPER PATTERN:

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

DISTRIBUTION OF QUESTIONS:

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

ELECTIVE -II
COURSE TITLE: DIFFERENCE EQUATIONS

SUBJECT CODE :19PMAT316	**THEORY**	**100 MARKS**
SEMESTER: III	**CREDITS: 3**	**TOTAL HOURS: 45**

COURSE OBJECTIVES:

- This course covers the mathematical foundations of numerical methods, with an emphasis onfinite difference and Z-transform, which are used to solve difference equations. Students will study the Sturmian theory and methods for obtaining numerical values for various types of physically significant green's functions in this course. To solve numerical problems involving disconjugacy, the Riccati equation, and oscillation, the student will analyze and apply finite difference and green function methods.

UNIT I **(9 hrs)**

Difference Calculus - First order equations - General results for linear equation - Solving linear equation.
Recommended Chapter-II: Sec 2.1 to 2.3 of W.G. Kelly and A.C. Petersan
Recommended Chapter-III: Sec 3.1 to 3.3 of W.G. Kelly and A.C. Petersan

UNIT II **(9 hrs)**

Equations with variable coefficients - Nonlinear equations that can be linearized.
Recommended Chapter-III: Sec 3.5, 3.6 of W.G. Kelly and A.C. Petersan

UNIT III **(9 hrs)**

z - transform - solving linear difference equation using z - transform.
Recommended Chapter-III: Sec 3.7 of W.G. Kelly and A.C. Petersan

UNIT IV **(9 hrs)**

Second order linear equation - Sturmian Theory - Green's function.
Recommended Chapter-VI: Sec 6.1 to 6.3 of W.G. Kelly and A.C. Petersan

UNIT V **(9 hrs)**

Disconjugacy - Riccati equation - Oscillation.
Recommended Chapter-VI: Sec 6.4 to 6.6 of W.G. Kelly and A.C. Petersan

PRESCRIBED BOOK:

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

REFERENCE BOOKS

1. S. Elayadi, An Introduction to Difference Equations, Springer New York 2005.
2. R.P. Agarwal Difference Equations and Inequalities, Marsel Dekker, New York, 2000.

QUESTION PAPER PATTERN:

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

DISTRIBUTION OF QUESTIONS:

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

ELECTIVE -III
COURSE TITLE: NUMBER THEORY AND CRYPTOGRAPHY

SUBJECT CODE:19PMAT317	**THEORY**	**100 MARKS**
SEMESTER: III	**CREDITS: 3**	**TOTAL HOURS: 75**

COURSE OBJECTIVE:

- A dynamic transform in number theory and cryptography technique.

UNIT-I **(15hrs)**

Elementary Number Theory: Time Estimates for doing arithmetic – divisibility and Euclidean algorithm – Congruences – Application to factoring.
Recommended Chapter 1: of Neal Koblitz.

UNIT-II **(15hrs)**

Introduction to Classical Crypto SystemsSome simple crypto systems – Enciphering matrices DES
Recommended Chapter 3: of Neal Koblitz.

UNIT-III **(15hrs)**

Finite Fields, Quadratic Residues and Reciprocity
Recommended Chapter 2: of Neal Koblitz.

UNIT-IV **(15hrs)**

Public Key Cryptography The idea of public key Cryptography – RSA – Discrete log – Knapsack - Zero-knowledge protocols and oblivious transfer
Recommended Chapter 4: of Neal Koblitz.

UNIT-V **(15hrs)**

Primality, Factoring, Elliptic curves and Elliptic curve crypto systems Pseudoprimes – The Rho method – Fermat factorization and factor bases - The continued fraction method - The quadratic sieve method
Recommended Chapter 5: sections 1, 2, 3 & 5, Chapter 6, sections 1&2
of Neal Koblitz.

PRESCRIBED BOOK:

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

REFERENCE BOOKS

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

QUESTION PAPER PATTERN:

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

DISTRIBUTION OF QUESTIONS:

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

CORE -XIII
COURSE TITLE: COMPLEX ANALYSIS -II

SUBJECT CODE :19PMAT318	**THEORY**	**100 MARKS**
SEMESTER: IV	**CREDITS: 4**	**TOTAL HOURS: 90**

COURSE OBJECTIVE:

- A deep study in complex analysis.

UNIT-I **(18 hrs)**

Riemann Zeta Function and Normal Famalies: Product development – Extension of $\zeta(s)$ tothe whole plane – The zeros of zeta function – Equicontinuity – Normality and compactness– Arzela's theorem – Families of analytic functions – The Classcial Definition

Recommended Chapter 5: Sections 4.1 to 4.4, Sections 5.1 to 5.5 of Lars V. Ahlfors

UNIT-II **(18 hrs)**

Riemann mapping Theorem: Statement and Proof –Boundary Behaviour –Use of the Reflection Principle.Conformal mappings of polygons:Behaviour at an angle Schwarz-Christoffel formula – Mapping of a rectangle. Harmonic Functions: Functions with mean value property – Harnack's principle.

Recommended Chapter 6: Sections 1.1 to 1.3 (Omit Section 1.4) Sections 2.1 to 2.3 (Omit section 2.4), Section 3.1 and 3.2 of Lars V. Ahlfors

UNIT-III **(18 hrs)**

Elliptic functions: Simply periodic fnctions – Doubly periodic functions

Recommended Chapter 7: Sections 1.1 to 1.3, Sections 2.1to 2.4 of Lars V. Ahlfors

UNIT-IV **(18 hrs)**

WeierstrassTheory:The Weierstrass $\wp$-function – The functions $\zeta(s)$ and $\sigma(s)$ – The differential equation – The modular equation $\lambda(\tau)$ – The Conformal mapping by $\lambda(\tau)$.

Recommended Chapter 7: Sections 3.1 to 3.5 of Lars V. Ahlfors

UNIT-V **(18 hrs)**

Analytic Continuation:TheWeiesrtrass Theory – Germs and Sheaves – Sections and Riemann surfaces – Analytic continuation along Arcs – Homotopic curves – The Monodromy Theorem – Branch points.

Recommended Chapter 8: Sections 1.1 to 1.7 of Lars V. Ahlfors

PRESCRIBED BOOK:

1. Lars V. Ahlfors, Complex Analysis, (3rd Edition) McGraw Hill Book Company, New York, 1979.

REFERENCE BOOKS

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

QUESTION PAPER PATTERN:

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

DISTRIBUTION OF QUESTIONS:

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

CORE -XIV
COURSE TITLE: DIFFERENTIAL GEOMETRY

SUBJECT CODE: 19PMAT319	**THEORY**	**100 MARKS**
SEMESTER: IV	**CREDITS:** 4	**TOTAL HOURS: 90**

COURSE OBJECTIVE:

- To find the length in geometrical approach.

UNIT-I **(18 hrs)**

Curves in the plane and inspace:Curves, parametrisation, arc length, level curves, curvature, plane and space curves.
Recommended Chapters: 1 and 2 of A. Pressley

UNIT-II **18 hrs)**

Surfaces in space: Surface patches, smooth surfaces, tangents, normals, orientability, examples of surfaces, lengths of curves on surfaces, the first fundamental form, isometries, surface area.
Recommended Chapter: 4 - 4.1, 4.2, 4.3, 4.4, 4.7 and Chapter 5 - 5.1, 5.2, 5.4of A. Pressley

UNIT-III **(18 hrs)**

Curvature of surfaces: The second fundamental form, Curvature of curves on a surface, normal, principal, Gaussian and mean curvatures, Gauss map.
Recommended Chapter: 6 - 6.1, 6.2, 6.3 and Chapter 7 -7.1, 7.5,7.6 of A. Pressley

UNIT-IV **(18 hrs)**

Geodesics: Geodesics, geodesic equations, geodesics as shortest paths, geodesic coordinates.
Recommended Chapter: 8 - 8.1, 8.2, 8.4, 8.5 of A. Pressley

UNIT-V **(18 hrs)**

TheoremEgregium of Gauss:Theorem,Egregium, isometries of surfaces, Codazzi-Mainardi equations, compact surfaces of constant Gaussian curvature.
Recommended Chapter: 10 of A. Pressley

PRESCRIBED BOOK:

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

REFERENCE BOOKS

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

QUESTION PAPER PATTERN:

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

DISTRIBUTION OF QUESTIONS:

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

CORE -XV
COURSE TITLE: FUNCTIONAL ANALYSIS

SUBJECT CODE : 19PMAT320	**THEORY**	**100 MARKS**
SEMESTER: IV	**CREDITS: 4**	**TOTAL HOURS: 90**

COURSE OBJECTIVE:

- A brief study in analyze about spaces.

UNIT-I **(18 hrs)**

Normed Spaces – Riesz lemma –Continuity of Linear Maps.
Recommended Chapter: II Sec 5.1 to 5.7, 6.1 to 6.5 of B.V.Limaye

UNIT-II **(18 hrs)**

Bounded Linear Maps – Hahn Banach Theorems – Hahn-Banachseparation theorem – Hahn-Banachextensiontheorems,Unique Hahn BanachExtensions – Banach Spaces. Recommended Chapter:II Sec 6.6 to 6.8, 7.1 to 7.11, 8.1 to 8.4 of B.V. Limaye

UNIT-III **(18 hrs)**

Uniform Boundedness Principle – Resonance theorem – Closed Graph Theorem– Open mapping Theorem – Bounded Inverse Theorem – Two-norm theorem.
Recommended Chapter:III Sec 9.1 to 9.3, 10.1 to 10.7, 11.1 to 11.3 of B.V. Limaye

UNIT-IV **(18 hrs)**

Spectrum of Bounded Operator – Weak and Weak* Convergence – Bolzano-Weierstrass Property – Reflexivity.
Recommended Chapter:III Sec 12.1 to 12.5Chapter-IV: Sec 15.1 to 15.4, 16.1 to 16.4 of B.V. Limaye

UNIT-V **(18 hrs)**

Inner Product Spaces – Orthonormal Sets – Bessel's Inequality – Bounded Operators –Normal, Unitary and Self - Adjoint Operators.
Recommended Chapter: VI Sec 21.1 to 21.3, 22.1 to 22.2,22.4 to 22.,Chapter-VII: Sec 25.2, 26.1 to 26.3 of B.V. Limaye

PRESCRIBED BOOK:

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

REFERENCE BOOKS

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

QUESTION PAPER PATTERN:

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Section A	**Definition / Principles** Answer any 10 out of 12 questions	1-12	3	30
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Section C	**Essay** Answer any 4 out of 6 questions	20-25	10	40
TOTAL MARKS				100

DISTRIBUTION OF QUESTIONS:

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

ELECTIVE -IV
COURSE TITLE: CALCULUS OF VARIATIONS AND INTEGRAL EQUATIONS

SUBJECT CODE :19PMAT321	THEORY	100 MARKS
SEMESTER: IV	CREDITS: 3	TOTAL HOURS: 75

COURSE OBJECTIVES:

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

UNIT I **(15hrs)**

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

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

UNIT II **(15 hrs)**

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

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

UNIT III **(15 hrs)**

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

Recommended Chapter-I: Sec 1.1 to 1.18 of M. D. Raisinghania

UNIT IV **(15hrs)**

Conversion of Ordinary Differential Equations into Integral

Equations: Initial Value Problems – Methods of Converting an Initial Value Problem into a Volterra Integral Equation – Boundary Value Problems – Examples - Methods of Converting a Boundary Value Problem into a Fredholm Integral Equation.

Recommended Chapter-II: Sec 2.1 to 2.6 of M. D. Raisinghania

UNIT V **(15 hrs)**

Homogeneous Fredholm Integral Equations: Characteristic

Values – Characteristic Functions – Solution of Homogeneous Fredholm Integral Equations of the

Second Kind with Separable Kernels-Solved examples.
Recommended Chapter-III: Sec 3.1 to 3.3 of M. D. Raisinghania

PRESCRIBED BOOKS:

1. A. S. Gupta, Calculus of Variations with Applications, Prentice-Hall of India, New Delhi, 1997. (for Units I and II)
2. M. D. Raisinghania, Integral Equations and Boundary Value Problems, S. Chand Publication (for Units III, IV and V)

REFERENCE BOOKS

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

QUESTION PAPER PATTERN:

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

DISTRIBUTION OF QUESTIONS:

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

ELECTIVE -V
COURSE TITLE: STOCHASTIC PROCESSES

SUBJECT CODE :19PMAT322	THEORY	100 MARKS
SEMESTER: IV	CREDITS: 3	TOTAL HOURS: 75

COURSE OBJECTIVE:

- To study the main concepts involving stochastic process.

UNIT-I **(15hrs)**

Introduction – Specification of stochastic processes – Stationary processes – Martingales– Markov chains: Definitions and examples –Higher transition probabilities.
Recommended Chapter II: Sections2.1 – 2.4,Chapter III: Sections3.1 – 3.2of J. MEDHI

UNIT-II **(15hrs)**

Classifications of states and chains – Determination of higher transition probabilities.
Recommended Chapter III: Sections 3.4 – 3.5ofJ. MEDHI

UNIT-III **(15hrs)**

Poisson process - Poisson process and related distributions.
Recommended Chapter IV: Sections 4.1 – 4.2 of J. MEDHI

UNIT – IV **(15hrs)**

Properties of generating functions of branching processes Probability of extinction– Distribution of the total number of progeny – Conditional limit laws.
Recommended Chapter IX:Sections 9.1 - 9.5.1of J. MEDHI

UNIT-V **(15hrs)**

General concepts – M/M/1 steady state behavior – Transient behaviour (Method of generating function) – Birth and death processes in queuing theory: Multi channel models.
Recommended Chapter X:Sections10.1 – 10.2, 10.3.2, 10.4.1, 10.4.2 of J. MEDHI

PRESCRIBED BOOK:

1. Stochastic Processes by J. MEDHI, 2nd Edition, New Age International (P) Ltd., 1984.

REFERENCE BOOKS

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

QUESTION PAPER PATTERN:

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

DISTRIBUTION OF QUESTIONS:

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