For students admitted from 2019-2020 onwards

M.Phil. Mathematics

Syllabus for Guide paper

SPECIALIZATION COURSE WILL BE ANY ONE OF THE FOLLOWING:

S.NO	COURSE CODE	TITLE OF THE SPECIALIZATION COURSE
1.	18URMAT0E01	COMMUTATIVE ALGEBRA
2.	18URMAT0E02	NON COMMUTATIVE ALGEBRA
3.	18URMAT0E03	ADVANCED TOPOLOGY
4.	18URMAT0E04	ADVANCED TOPICS IN GRAPH THEORY
5.	18URMAT0E05	GEOMETRIC FUNCTION THEORY
6.	18URMAT0E06	FUNCTIONAL EQUATIONS
7.	18URMAT0E07	MATHEMATICAL MODELLING
8.	18URMAT0E08	ORDINARY DIFFERENTIAL AND DIFFERENCE EQUATIONS
9.	18URMAT0E09	FRACTIONAL DIFFERENTIAL EQUATIONS
10.	18URMAT0E10	THEORY OF PARTIAL DIFFERENTIAL EQUATIONS
11.	18URMAT0E11	ADVANCED TOPICS IN FLUID DYNAMICS
12.	18URMAT0E12	FUZZY SETS: THEORY AND APPLICATIONS
13.	18URMAT0E13	OPTIMIZATION TECHNIQUES

18URMAT0E01	COMMUTATIVE ALGEBRA	L	T	P	C
		4	1	0	4

UNIT I: Modules

Free modules – Direct sum of sub modules – Projective modules – Shanuel's Lemma – Tensor products – Flat modules – Faithfully flat modules.

UNIT II: Localisation

Ideals – Chinese remainder theorem – Extended and contracted ideals local rings – Nakayama Lemma – Localisation – Applications.

UNIT III: Noetherian Rings

Noetherian modules – Hilber's Basis theorem – Primary decomposition – first and second uniqness theorems – Artinian modules – structure of artinian rings – length of a module.

UNIT IV: Integral Extensions

Integral elements – integral extensions – goingup theorem – integrally closed domains – goindown theorem – finiteness of integral closure – Noether's Normalisation theorem – Valuation rings.

UNIT V: Integral Domain and completions

Discrete valuation rings – Dedekind domain – ramification formula – feltered rings and modules –completion – I-adic filtration – Krull's Intersection theorem – associated graded rings – Hensel's lemma.

TREATMENT AS IN:

N.S. Gopala Krishnan, Commutative Algebra, University Press, Hyderabad, india, 2016.

REFERENCES:

1. **M.F. Atiyah** and **I.G. Macdonald**, Introduction to Commutative Algebra, Westview Press, Kolkata, India, 2007.
2. **N. Bourbaki**, Commutative Algebra, Chapter 1-7, Springer, 1985.
3. **I. Kaplansky**, Commutative Rings, Allyn and Abcon, Boston, 1970.

4. **H. Masumura**, Commutative Ring Theory, Cambridge Studies in Mathematics Vol.8, Cambridge University Press, Cambridge, 1985.
5. **M. Reid**, Undergraduate Commutative Algebra, LMS Student Texts, Vol. 29, Cambridge University Press, Cambridge, 1997.

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		L	T	P	C
18URMAT0E02	**NON COMMUTATIVE ALGEBRA**	4	1	0	4

UNIT I: Decompositions of Rings:

Modules and homomorphisms – classical isomorphism theorems – direct sums and products – finitely generated and free modules – two sided Peirce decomposition of a ring – the Wedderburn – Artin theorem – lattices, Boolean algebras and rings - finitely decomposable rings.

UNIT II: Artinian and Noetherian Rings:

Artinian and Noetherian modules and rings - the Jordan-Holder theorem – the Hilbert basis theorem – the radical of a module and a ring – the radical of Artinian rings – a criterion for a ring to be Artinian or Noetherian - Semiprimary rings.

UNIT III: Integral Domains

Principal ideal domains – factorial rings – Euclidean domains – Rings of fractions and quotient fields – Polynomial rings over fractional rings –Smith normal form over a PID – finitely generated modules over a PID – the Frobenius theorem.

UNIT IV: Dedekind Domains

Integral closure – Dedekind domains – hereditary domains – discrete valuation rings – finitely generated modules over Dedekind domains – Puüfier rings.

UNIT III: Goldie rings and Semiperfect rings

The Ore condition – classical rings of fractions – Prime and semiprime rings – Goldie rings – Goldie’s theorem -Local and semilocal rings – noncommutative discrete valuation rings – lifting idempotent – semiperfect rings.

TREATMENT AS IN:

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

REFERENCE BOOKS:

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. **P.E. Bland**, *"Rings and their Modules*", Walter de GmbH Co.KG, Berlin New York, 2011.
5. **J.C. Mc Connel** and **J.C. Robson**, *"Noncommutative Noetherian Rings*", Graduate Studies in Mathematics, Vol.30, AMS, Providence, 2001.

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		L	T	P	C
18URMAT0E03	**ADVANCED TOPOLOGY**	4	1	0	4

UNIT I:

Fundamental Group and covering spaces: Homotopy, Fundamental Group and Covering Spaces.

Chapter 3 (Sections 3.1, 3.2 and 3.3)

UNIT II:

Simplical Complexes: Geometry of simplical complexes, Barycentric subdivisions, Simplical approximation theorem.

Chapter 4 (Sections 4.1, 4.2 and 4.3)

UNIT III:

The Tychonoff Theorem: The Tychonoff theorem, The Stone-CechCompactification. Metrization theorems and Para compactness: Local Finiteness, The Nagata – Smirnov Metrization theorem.

Chapter 5 (Sections 37, 38), Chapter 6 (Sections 39, 40)

UNIT IV:

Para Compactness, The Smirnov Metrization theorem. Complete Metric spaces and Function spaces: Complete metric spaces, A space-filling curve.

Chapter 6 (Sections 41, 42), Chapter 7 (Sections 43, 44)

UNIT V:

Compactness in Metric spaces, Pointwise and compact convergence, Ascoli's theorem.

Chapter 7 (Sections 45, 46 and 47)

TREATMENT AS IN:

1. **M. Singer** and **J. A. Thorpe**, "Lecture Notes on Elementary Topology and Geometry", Springer – Verlag, New York, 1967. (Units I & II)
2. **James R. Munkres**. , "Topology", Pearson Education Limited, 2009. (Units – III to V)

REFERENCE BOOKS:

1. **Bert Mendelson**, Introduction to Topology, 3rd Edition, Dover publications, 1990.
2. **T.W. Gavnelin** and **R.E. Green**, Introduction to Topology, 2nd Edition, Dover Publications, 1997.
3. **G.E. Bredon**, Topology and Geometry, GTM Vol. 139, Springer-Verlag, 1993.
4. **J. Milnor**, Topology from the Differential Viewpoint, Revised Edition, Princeton University press, 1997.
5. **A.R. Kosinsk**, Differential Manifolds, Dover publications, 2007.

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		L	T	P	C
18URMAT0E04	**ADVANCED TOPICS IN GRAPH THEORY**	4	1	0	4

UNIT I:

Perfect graphs

UNIT II:

Other classes of perfect graphs

UNIT III:

Labeling of graphs

UNIT IV:

Factorizations and decompositions

UNIT V:

Domination in graphs

TREATMENT AS IN:

1. **D.B. West**, Introduction to Graph Theory, PHI (2002).
   Unit – I & II – Chapter 8.1 (Imperfect graphs excluded)
2. **G. Chartrand** and **L. Lesniak**, Graphs and Digraphs, Chapen & Hall / CRC press, 1996.
   - UNIT III – Chapter 9; Section 3
   - UNIT IV – Chapter 9; Section 2
   - UNIT V – Chapter 10; Section 1 and 2

REFERENCES:

1. **R. Balakrishnan** and **K. Ranganathan**, A TREATMENT AS IN of Graph Theory, Springer, 2000.
2. **A. Gibbons**, Algorithmic Graph Theory, Cambridge University Press, Cambridge, 1989.
3. **R.J. Wilson** and **J.J. Watkins**, Graphs: An Introducing Approach, John Wiley and sons, New York, 1989.
4. **K.R. Parthasarathy**, Basic Graph Theory, Tata Mc – Graw Hill Publishing Company New Delhi, 1994.

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18URMAT0E05	GEOMETRIC FUNCTION THEORY	L	T	P	C
		4	1	0	4

UNIT I: Elementary Theory of Univalent Functions

Basic Principles – Local mapping properties – Normal families – Extremal problems – The Riemann mapping theorem – Analytic continuation – The area theorem-growth and distortion theorem-coefficients estimates – convex and starlike functions – close-to-convex functions –Exercises.

UNIT II: Some Theorems on Power Series

Coefficients for the Area theorem – Coefficients for the inverse of a function – Transformation of the range from the unit disk to the right half-plane – problems.

UNIT III: Subordination

Basic principles – coefficient inequalities – sharpened forms of the Schwarz lemma – Majorization – univalent subordination functions – Exercises

UNIT IV: Convex and Starlike Functions

Convexity and starlikeness on a curve - functions univalent in the unit disk – Ford's theorem - Alexander's theorem -Sharp bounds for the coefficients – Two radius problems - Integral representations - The Schwarz – Christoffel transformation. Univalent functions with real coefficients

UNIT V: Typically – Real Valued Functions

The region of values at a point - Functions that are convex in one direction - functions with positive real part and real coefficients.

TREATMENT AS IN:

1. **P. L. Duren**, Univalent Functions, Springer-Verlag, New York, 1984.
2. **A. W. Goodman**, Univalent Functions, Vol - I & II, Mariner Publication company, Florida, 1984.

REFERENCE BOOKS:

1. **Graham, G. Kohr**, Geometric Function Theory in One and Higher Dimensions, Marcel Dekker Inc., New York-Basel, 2003.
2. **Ch. Pommerenke**, Univalent Functions, Vanderhoeck and Ruprecht, Gottingen,1975.

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		L	T	P	C
18URMAT0E06	**FUNCTIONAL EQUATIONS**	4	1	0	4

UNIT I: Additive Cauchy Functional Equations

Introduction – Functional Equations – Solution of Additive Cauchy Functional Equation – Discontinuous Solution of Additive Cauchy Equation – Other Criteria for Linearity – Additive Functions on the Complex plane – Jensen and Pexider's Functional Equations. [Chapter 1-Scetions: 1.1 – 1.6 and Chapter 7-Sections: 7.1-7.4, Chapter 8-Sections: 8.1-8.4].

UNIT II: Quadratic Functional Equation and its Stability

Introduction – Biadditive Functions – Continuous Solution of Quadratic Functional Equations – A Representation of Quadratic Functions – Pexiderization of Quadratic Equation – Stability of Quadratic Equation – Stability of Generalized Quadratic Equation – d'Alembert Functional Equations and Hosszu Functional Equation. [Chapter 9-Sections: 9.1-9.5, Chapter 10 – Sections 10.1 – 10.4 and Chapter 13 – Sections: 13.1 – 13.3 and Chapter 21-Sections: 21.1 -21.4].

UNIT III: Remaining Cauchy Functional Equations

Introduction – Solution of Exponential Cauchy Equation – Solution of the Logarithmic Cauchy Equation – Solution of the Multiplicative Cauchy Equation. [Chapter 2-Sections: 2.1-2.4].

UNIT IV: Trigonometric Functional Equations

Introduction – Solution of a Cosine-Sine Functional Equation – Solution of a Sine – Cosine Functional Equation - Solution of a Sine Functional Equation – Solution of a Sine Functional Inequality – An Elementary Functional Equation. [Chapter 11: Sections: 11.1-11.6].

UNIT V: Banach Algebras – Hyers –Ulam Stability

Stability of the Positive – Additive Functional Equations: The Fixed Point Method – Stability of the Positive – Additive Functional Equations: The Direct Method - *-Homomorphism in JC*-Algebras – Stability of *-Homomorphism in JC*-Algebras – Stability of C-Linear Mappings in Banach Spaces – Stability of Homomorphism in Proper CQ*-Algebras – Stability of Derivations in Proper CQ*-Algebras – Functional Equations and Their Applications. [Chapter 3-Sections : 3.10-3.11 Chapter 4- Sections: 4.1, Chapter 4: Sections : 4.1 -4.2].

TREATMENT AS IN:

1. **Prasanna K. Sahoo** and **Palaniappan Kannappan**, Introduction to Functional Equations, Taylor & Francis Group, London, 2011.
2. **Yeol Je Cho, Choonkil Park, Themistocles M. Rassias,** and **Reza Saadati**, Stability of Functional Equations in Banach Algebras, Springer –Verlag, New York, 2015.

REFERENCES:

1. **J. Aczel**, Lectures on Functional Equations and their Applications, Academic Press, New York, 1966.
2. **E. Castilo** and **M.R. Ruiz-Cobo**, Functional Equations and Modelling in Science and Engineering, Marcel Dekker, Inc., 1992.
3. **Marek kuczma**, An Introduction to the theory of Functional Equations and Inequalities: Cauchy's Equation and Jensen's Inequality, Birkhauser, 2009.
4. **S. Czerwik**, Functional Equations and Inequalities in Several Variables, World Scientific, Singapore, 2002.
5. **D.H. Hyers, G. Issac** and **Th. M. Rassias**, Stability of Functional Equations in Several Variables, Birkhauser, Basel, 1998.

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18URMAT0E07	MATHEMATICAL MODELLING	L	T	P	C
		4	1	0	4

UNIT I: Continuous Population Models

Continuous Growth Models - Insect Outbreak Model: Spruce Budworm - Delay Models - Linear Analysis of Delay Population Models: Periodic Solutions.

Reaction Diffusion – Chemotaxis: Simple Random Walk and Derivation of the Diffusion Equation - Reaction Diffusion Equations – Chemotaxis.

UNIT II: Models for Interacting Populations

Predator–Prey Models: Lotka–Volterra Systems - Complexity and Stability - Realistic Predator–Prey Models - Analysis of a Predator–Prey Model with Limit Cycle Periodic Behaviour: Parameter Domains of Stability - Competition Models: Competitive Exclusion Principle - Mutualism or Symbiosis - General Models and Cautionary Remarks - Threshold Phenomena.

UNIT III: Reaction Kinetics

Enzyme Kinetics: Basic Enzyme Reaction - Transient Time Estimates and Nondimensionalisation - Michaelis–Menten Quasi-Steady State Analysis - Suicide Substrate Kinetics - Cooperative Phenomena - Autocatalysis, Activation and Inhibition - Multiple Steady States, Mushrooms and Isolas.

UNIT IV: Dynamics of Infectious Diseases

Historical Aside on Epidemics-Simple Epidemic Models and Practical Applications-Modelling Venereal Diseases - Multi-Group Model for Gonorrhea and Its Control - AIDS: Modelling the Transmission Dynamics of the Human Immunodeficiency Virus (HIV) - HIV: Modelling Combination Drug Therapy - Delay Model for HIV Infection with Drug Therapy

Modelling the Population Dynamics of Acquired Immunity to Parasite Infection

UNIT V: Spatial Pattern Formation with Reaction Diffusion Systems

Role of Pattern in Biology - Reaction Diffusion (Turing) Mechanisms - General Conditions for Diffusion-Driven Instability: Linear Stability Analysis and Evolution of Spatial Pattern

- Detailed Analysis of Pattern Initiation in a Reaction Diffusion Mechanism - Dispersion Relation, Turing Space, Scale and Geometry Effects in Pattern Formation Models - Mode Selection and the Dispersion Relation - Pattern Generation with Single-Species Models: Spatial Heterogeneity with the Spruce Budworm Model - Spatial Patterns in Scalar Population Interaction Diffusion Equations with Convection: Ecological Control Strategies - Nonexistence of Spatial Patterns in Reaction Diffusion Systems: General and Particular Results.

TREATMENT AS IN:

1. **J.D. Murray, "**Mathematical Biology I: An Introduction", Springer-Verlag, New York, 2002.
2. **J.D. Murray, "**Mathematical Biology II: Spatial Models and Biomedical Applications", Springer-Verlag, New York, 2003.

REFERENCES:

1. **A. D. Bazykin,** "Nonlinear Dynamics of Interacting Populations", World Scientific, 1998.
2. **N. Britton,** "Essential Mathematical Biology", Springer Science & Business Media, 2012.
3. **J.N.Kapur,** "Mathematical Models in Biology And Medicine", Affiliated East–West, New Delhi, 1985.

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<table>
<tr><td rowspan="2">18URMAT0E08</td><td rowspan="2">ORDINARY DIFFERENTIAL AND DIFFERENCE EQUATIONS</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
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UNIT I: Sturm-Type Theorems for Second Order Ordinary Equations

Comparison Theorems for Self - Adjoint Equations - Additional Results of Leighton - Extension to General Second Order Equations - Comparison Theorems for Singular Equations - Comparison Theorems for Eigen functions.

(Chapter 1: Sections 1 - 5 of [1])

UNIT II: Oscillation and Non-oscillation Theorem for Second Order Ordinary Equation

The Oscillation Criteria of Hille and Nehari - Conditionally Oscillatory Equations - Nehari's Comparsion Theorems - The Hille-Winter Comparision Theorem - Hille Necessary and Sufficient Conditions for Nonoscillatory Equations -Leighton's Oscillation Criteria - Potter's Oscillation Criteria - Hille's Kneser-Type Oscillation Criteria - Nonoscillation Theorems of Hartman and Wintner - Nonoscillation criteria for Hille's Equation.

(Chapter 2: Sections 1 – 9 and 11 of [1])

UNIT III: Oscillations of Neutral Differential Equations

Oscillations and asymptotic behaviour of scalar neutral delay differential equations - Oscillations of scalar neutral equations with mixed arguments - Necessary and sufficient conditions for the oscillation of systems of neutral equations - Oscillations of scalar neutral equations with variable coefficients - Differential inequalities and comparison theorems - Linearized oscillations for neutral equations - Existence of positive solutions - Oscillations in neutral delay logistic differential equations - Oscillations in non-autonomous equations with several delays -Oscillations in a system of neutral equations.

(Chapter 6: Sections 6.1 – 6.10 of [2])

UNIT IV: Linear Difference Equations of Higher Order

Difference Calculus – General Theory of Linear Difference Equations – Linear Homogeneous Equations with Constant Coefficients – Linear Non homogeneous Equations: Method of Undetermined Coefficients – Limiting Behavior of Solutions – Nonlinear Equations Transformable to Linear Equations - Applications.

(Chapter 2: Sections 2.1 – 2.7 of [3])

UNIT V: Systems of Difference Equations

Autonomous Systems – The Basic Theory – The Jordan Form: Autonomous Systems Revisited – Applications.

(Chapter 3: Sections 3.1 – 3.5 of [3])

TREATMENT AS IN:

1. **C. A. Swanson**, Comparison and Oscillation Theory of Linear Differential Equations, *Academic Press, New York and London*, 1968.
2. **I. Gyori** and **G. Ladas**, Oscillation Theory of Delay Differential Equations with Applications, *Clarendon Press, Oxford*, 1991.
3. **Saber Elaydi**, An Introduction to Difference Equations, 2^{nd} edition, Trinity University, *San Antonio, Texas, 1995*.

REFERENCES:

1. **K. Gopalsamy** and **Kluwer**, Stability and Oscillations in Delay Differential Equation of Population Dynamics, *Academic Publishers*, 1992.
2. **S. H. Saker**, Oscillation theory of delay differential and difference equations, VDM Verlag Dr.Muller Aktiengesellschaft and Co, *USA*, 2010.
3. **K.S. Miller**, Linear Difference Equations, New York, 1968.
4. **W.G. Kelley** and **A.C. Peterson**, Difference Equations, An Introduction with Applications, Academic Press, New York, 1991.

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		L	T	P	C
18URMAT0E09	**FRACTIONAL DIFFERENTIAL EQUATIONS**	4	1	0	4

UNIT I: Grunwald-Letnikov Fractional Derivatives

Unification of integer-order derivatives and integrals – Integrals of arbitrary order – Derivatives of arbitrary order – Fractional derivative of (t – a)^β - Composition with integer-order derivatives – Composition with fractional derivatives.

Unit-II: Riemann – Liouville Fractional Derivatives

Unification of integer-order derivatives and integrals – Integrals of arbitrary order – Derivatives of arbitrary order – Fractional derivative of (t – a)^β - Composition with integer-order derivatives – Composition with fractional derivatives – Link to the Grunwald – Letnikov Approach.

Unit-III: Properties of Fractional Derivatives

Linearity – The Leibniz rule for fractional derivatives – Fractional derivative of a composite function – Riemann–Liouville fractional differentiation of an integral depending on a parameter – Behaviour near the lower terminal - Behaviour far from the lower terminal.

Unit-IV : Some other Approaches and Laplace Transforms of Fractional Derivatives

Caputo's fractional derivative – Generalized functions approach - Sequential fractional derivatives – Left and right fractional derivatives – Basic facts on the Laplace transform - Laplace transform of the Riemann–Liouville fractional derivative - Laplace transform of the Caputo derivative - Laplace transform of the Grunwald – Letnikov fractional derivative - Laplace transform of the Miller-Ross sequential fractional derivative.

Unit-V : Existence and Uniqueness Theorems

Linear fractional differential equations - Fractional differential equations of a general form - Existence and uniqueness theorem as a method of solution – Dependence of a solution on initial conditions.

<u>TREATMENT AS IN:</u>

I. Podlubny, Fractional Differential Equations, Academic press, London, 1999.

<u>REFERENCES:</u>

1. **K.S. Miller and B.Ross**, An introduction to the Fractional Calculus and Fractional Differential Equations, John Wiley & Sons, New York, 1993.
2. **A. A. Kilbas, H. M. Srivastava** and **J. J. Trujillo**, Theory and Applications of Fractional Differential Equations, Elsevier, Amsterdam, 2006.

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		L	T	P	C
18URMAT0E10	**THEORY OF PARTIAL DIFFERENTIAL EQUATIONS**	4	1	0	4

UNIT I: Linear Partial Differential Equations

Laplace equation: Fundamental solution – Mean-value formulas – Properties of harmonic functions – Green's functions - Heat equations: Fundamental solution – Mean-value formula – Properties of solutions
(Section 2.2 - 2.2.1 – 2.2.4 only, 2.3 – 2.3.1 – 2.3.3 from [1])

UNIT II: Other Ways to Represent Solutions
Separation of variables – Similarity solutions – Transformation methods
(Sections 4.1 – 4.3 only from [1])

UNIV III: Distributions
Preliminary ideas - Test Functions and Mollifiers – Distributions – Calculus – Fourier Transforms
(Sections 7.1 – 7.4, 7.6 from [2])

UNIT IV: Sobolev Spaces
An abstract construction - Approximations by Smooth Functions and Extensions – Traces
(Sections 7.7, 7.8, 7.9 only from [2])

Unit V: Variational Formulation of Elliptic Problems
Elliptic equations – Poisson problem – Diffusion, Drift and Reaction – Variational formulation of Poisson's problem – Dirichlet problem - Neumann, Robin and mixed problems - Regularity
(Sections 8.1, 8.2, 8.3, 8.4 – 8.4.1, 8.4.2, 8.6 only from [2])

TEXTBOOKS:

1. **L. C. Evans,** Partial Differential Equations, Graduate studies in Mathematics, Volume 19, American Mathematical Society, 2009.
2. **S. Salsa,** Partial Differential Equations in Action: From Modelling to Theory, Springer, Milan, 2008.

BOOKS FOR REFERENCE:

1. **R.A. Adams** and **J.F.Fournier**, Sobolev Spaces, Academic Press, New York, Second Edition, 2003.

2. **H. Brezis**, Functional Analysis, Sobolev Spaces and Partial Differential Equation, Springer, 2011.
3. **S. Kesavan**, Topics in Functional Analysis and Applications, New Age International, New Delhi, 2015.
4. **R.C.McOwen**, Partial Differential Equations: Methods and Applications, Second Edition, Pearson Education, New Delhi, 2005.

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		L	T	P	C
18URMAT0E11	**ADVANCED TOPICS IN FLUID DYNAMICS**	4	1	0	4

UNIT I:

Some features of viscous flows: Real and ideal fluids – Viscosity - Reynolds number – Laminar and turbulent flows – Asymptotic behavior at large Reynolds number. Boundary layer theory: Boundary layer concepts – Laminar boundary layer on a flat plate – Turbulent boundary layer on a flat plate – Fully developed turbulent flow in a pipe.

UNIT II:

Field Equations for flows of Newtonian field : Continuity equation – Momentum equation - Navier Stokes equation – Energy equation – Equation of motion for arbitrary co- ordinate systems – Exact solution of Navier stokes equation – Steady plane flows : Couette – Poiseuille flow – Flow past a circular cylinder – Steady axisymmetric flows – Circular Pipe flow - Flow between two concentric rotating cylinders.

UNIT III:

Thermal boundary layers in laminar flow: Derivation of the energy equation – Temperature increase through adiabatic compression - Stagnation temperature – Theory of similarity in heat transfer - Exact solutions for the problem of temperature distribution in a viscous flow - Boundary layer simplifications.

UNIT IV:

Magnetohydrodynamics: Electrodynamics of moving media – The electromagnetic effects andthe magnetic Reynolds number - Alfven's theorem – The magnetic energy - The mechanical equations - Basic equations for the incompressible MHD - Steady Laminar motion - Hartmann flow.

UNIT V:

Magneto hydrodynamic waves - waves in an infinite fluid of infinite electrical conductivity -Alfven waves - Magnetohydrodynamic waves in a compressible fluid - Magneto acoustic waves- Slow and Fast waves - Stability - Physical concepts – Linear Pinch-Kink - Sausage and Flute types of instability - Method of small oscillations – Jeans criterion for gravitational stability.

TREATMENT AS IN

1. **H. Schlichting**, and **K. Gersten**, Boundary - Layer Theory, Springer-Verlag, New York, 2003, Relevant topics from chapter 1,2,3,5 and 12.
2. **V. C. A. Ferraro** and **C. Plumpton**, An Introduction to Magneto Fluid Dynamics, Oxford: Clarendon Press, 1966, Relevant topics from Chapters 1,2,3 and 5.

REFERENCES:

1. **P. A. Davidson**, An Introduction to Magneto hydrodynamics, Cambridge University Press, Cambridge, 2001.
2. **P. K. Kundu**, I. M. Cohen, Fluid Mechanics, Academic Press, London, 2002.

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18URMAT0E12	**FUZZY SETS: THEORY AND APPLICATIONS**	L	T	P	C
		4	1	0	4

UNIT I:

CRISP SETS AND FUZZY SETS: Introduction –Crisp Sets: An Overview-The Notion of Fuzzy Sets - Classical Logic: An Overview –Fuzzy Logic. OPERATIONS ON FUZZY SETS: General Discussion –Fuzzy Complement-Fuzzy Union –Fuzzy Intersection – Combinations of Operations – General Aggregation Operations. FUZZY MEASURES: Belief and Plausibility measures- Probability measures –possibility and Necessity measures.

UNIT II:

FUZZY SYSTEMS: General Discussion – Fuzzy Controllers: An Overview – Fuzzy Controllers: An Example – Fuzzy Systems and Neural Networks – Fuzzy Automata – Fuzzy Dynamic Systems. PATTERN RECOGNITION: Introduction – Fuzzy clustering-Fuzzy pattern Recognition - Fuzzy Image Processing. APPLICATIONS: General Discussion - Natural,life, and Social Sciences- Engineering –Medicine-Management and Decision Making - Computer Science-Systems Science - Other Applications.

UNIT III:

FUZZY GRAPHS: Introduction – Operations on fuzzy Graphs – Cartesian Product and Composition – Union and Join paths and Connectivity- Bridges and Cut Vertices-Forests and trees- Trees and cycles- A Characterization of Fuzzy Trees –Fuzzy Cut Sets- Fuzzy Chords- Fuzzy Cotrees - Fuzzy Line Graphs-Fuzzy Interral Graphs- Fuzzy Intersection Graphs-The Fulkerson and Gross Characterization-The Gilmore and Hoffman Characterization.

UNIT IV:

INTUITIONISTIC FUZZY SETS: Definition - operations and Relations-Properties - Intuitionistic Fuzzy sets of a Certain Level - Necessity and possibility Operators – Topological Operators- Geometrical Interpretations.

UNIT V:

INTUITIONISTIC FUZZY RELATIONS: Cartesian Products over IFSS – Index Matrix-Basic Definition and properties - Other Definitions and properties - Intuitionistic Fuzzy Index Matrices- Intuitionistic Fuzzy Relations- Intuitionistic Fuzzy Graphs – Example- Experts who order Alternatives –Measurement tools that Evaluate Alternatives- Some Ways of Determining Membership and Non-membership Functions.

TREATMENT AS IN:

1. **George J. Klir** and **Bo Yuan**, Fuzzy sets and fuzzy logic: Theory and Applications Prentice Hall of India Private Limited. New Delhi, 2008. (for Units I & II)
2. **John N. Mordeson** and **Premchand S. Nair**, Fuzzy Graphs and Fuzzy Hypergraphs, Physica- Verlag Heidelberg,2000. (for Unit III)

3. **Krassimir T Atanassov**, On Intuitionistic Fuzzy Sets Theory, Springer - Verlag, Heidelberg, 1999. (for Units IV & V)

REFERENCES:

1. **A.I. Ban**, Intuitionistic Fuzzy Measures: Theory and Applications, Nova Science Publishers, New York, 2006.
2. **J.J. Buckl**ey, AND **E. Eslami**, An Introduction to Fuzzy Logic and Fuzzy Sets, Physica- verlag, Heidelberg, 2002.

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		L	T	P	C
18URMAT0E13	**OPTIMIZATION TECHNNIQUES**	4	1	0	4

UNIT I: Dynamic Programming

Elements of the DP Model: The Capital Budgeting – More on the Definition of , the state- Examples of DP models and computations - Problem of Dimensionality in Dynamic programming - Solution of Linear programs by Dynamic programming.

UNIT II: Decision Theory, Games and Inventory Model

Decisions under Risk - Decision Trees – Decisions Under Uncertainty - Game Theory - The ABC Inventory System - Generalized Inventory Models – Deterministic Models – Just-in-Time (JIT) manufacturing system.

UNIT III: Stochastic Process

Introduction – Classification – Stationary Process – Time Average – Ergodic Process – Markov Process and Markov Chain – Poisson Process – Renewal Process.

UNIT IV: Queuing Models

Role of Poisson and Exponential Distribution – Processes of Birth and Processes of Death - Queues with Combined Arrival and Departures - Non-Poisson Queues - Queues with Priorities for Service – Queueing Network

UNIT V: Nonlinear Programming

Unconstrained Extremal Problems – Constrained Extremal Problems - Nonlinear Programming Algorithm - Unconstrained Nonlinear Algorithms - Constrained Nonlinear Algorithms.

TREATMENT AS IN:

1. **H. A. Taha**, Operations Research -An Introduction, Fifth Edition, Prentice Hall of India (P) Limited, New Delhi, 1996.
2. **J. Medhi**, Stochastic Processes**,** Second edition, New York, Wiley.

REFERENCES:

1. **D. Ravindran, T. Phillips**, and **J. J. Solberg**, Operations Research: Principles and Practice, Second Edition, John Wiley & Sons (Asia), New Delhi, 2006.
2. **S. S. Rao**, Engineering Optimization, Third Edition, New Age International (p) Ltd, New Delhi, 1996.