शिवाजी विद्यापीठ कोल्हापूर
ज्ञानमेवामृतम्
Estd. 1962
NAAC 'A' Grade
MHRD NIRF-28th Rank

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दुरध्वनी (ईपीएबीएक्स) २६०९००० (अभ्यास मंडळे विभाग– २६०९०९४)
फॅक्स : ००९१-०२३१-२६९१५३३ व २६९२३३३.e-mail:bos@unishivaji.ac.in

SU/BOS/Sci & Tech/6823 **Date : 10/11/2017**

To,

Head of Department,
Department of Mathematics,
Shivaji University,
Kolhapur.

Subject: Regarding syllabus of **M.Phil. / Pre Ph. D. Mathematics** course under the Faculty of Science and Technology.

Sir/Madam,

With reference to the subject mentioned above, I am directed to inform you that the university authorities have accepted and granted approval to the syllabus of **M.Phil. / Pre Ph. D. Mathematics** course under the Faculty of Science and Technology.

This syllabus will be implemented from the academic year 2017-18 i.e. from June 2017 onwards.

You are therefore, requested to bring this to the notice of all students and teachers concerned.

Thanking you,

Yours faithfully,

Dy. Registrar

Shivaji University Kolhapur
Department of Mathematics

Revised Syllabus
for M.Phil. / Pre Ph.D.
to be implemented from
June 2017 onwards

List of papers

Compulsory Papers

Paper I Research Methodology

Paper II Recent Trends in Mathematics

Optional papers: Paper III

1. Theory of Fractional Dynamic Systems
2. Differential and Integral Inequalities
3. Delay Differential Equations
4. Iterative Methods
5. Atomistic and Multiplicative Lattices
6. Generalized Integral Transformations
7. Trellis Theory
8. Commutative Algebra
9. Theory of Near Rings
10. Topics in General Relativity
11. Theory of Choice
12. Theory of Fuzzy Computation
13. Lattices Theory
14. Topics in Geometric Function Theory
15. Fluid Dynamics
16. Fuzzy Measures and Integrals
17. Numerical Analysis III
18. Group Analysis of Differential Equations
19. Mathematical Modeling

NEW/REVISED SYLLABUS FOR
M. Phil./Pre Ph. D
(Introduced from June 2017 onwards)
Paper - I
Research Methodology

Unit I: Mathematical Writing: What Is a Theorem?, Proofs, The Role of Examples, Definitions, Notation, Words versus Symbols, Displaying Equations, Parallelism, Dos and Don'ts of Mathematical Writing.
Writing a Paper: Audience, Organization and Structure, Title, Author List, Date, Abstract, Key Words and Subject Classifications. (**15 Lectures**)

Unit II: Writing a Paper (Continued...): The Introduction, Review of Literature, Computational Experiments, Tables, Citations, Conclusions, Acknowledgements, Appendix, Reference List, Specifics and Deprecated Practices.
Revising a Draft: How to Revise, Examples of Prose, Examples Involving Equations, Examples from My Writing, A Revised Proof, A Draft Article for Improvement. (**15 Lectures**)

Unit III: Publishing a Paper: Choosing a Journal, Submitting a Manuscript, The Refereeing Process, How to Referee, The Role of the Copy Editor, Checking the Proofs, Copyright Issues, SIAM Journal Article: A case study.
Writing and Defending a Thesis: The Purpose of a Thesis, Content, Presentation, The Thesis Defence.
(**15 Lectures**)

Unit IV: Quality indices of research publication: impact factor, H- index, science citation index.
Using web for literature review: Google Scholar, Scopus, MathSciNet.
Latex and Beamer for paper typing and presentations: Latex -Typesetting Mathematics, Typesetting Theorems. Making Presentations with LATEX-Beamer. (**15 Lectures**)

References:

1. Higham Nicholas J., Handbook of writing for the mathematical sciences, SIAM, 1961.
2. Stegmann J., How to evaluate journal impact factors, Nature, 390(6660), (1997), 550-550.
3. Kaltenborn K. F. and Kuhn K, The journal impact factor as a parameter for the evaluation of researchers and research, Revista Espanola de Enfermedades Digestivas, 96(7), (2004), 460-476.
4. Hirsch J. E., An index to quantify an individual's scientific research output, https://arxiv.org/abs/physics/0508025
5. Garfield E., The evolution of the Science Citation Index, International Microbiology, 10, (2007), 65-69. DOI: 10.2436/20.1501.01.10
6. LATEX Tutorials A Primer, Indian TEX Users Group, Trivandrum, India, 2003 September.
https://www.tug.org/twg/mactex/tutorials/ltxprimer-1.0.pdf
7. Tantau T., Wright J. and Miletić V., The beamer class: User Guide for version 3.42, *Published as part of the beamer package* (2015).
http://ctan.imsc.res.in/macros/latex/contrib/beamer/doc/beameruserguide.pdf
8. Hoff Katharina, LATEX-beamer Course, (2007). http://gobics.de/katharina/beamer-script.pdf

Additional Readings:

1. A Primer of Mathematical Writing, Steven G. Krantz, Universities Press Hyderabad 1998.
https://arxiv.org/pdf/1612.04888.pdf
2. McGraw-Hill's Concise Guide to Writing Research Papers, Carol Ellison, McGraw-Hill, New York, 2010.

NEW/REVISED SYLLABUS FOR
M. Phil. / Ph.D. Course Work
Paper: II
Title of Paper: Recent Trends in Mathematics

Unit I: Preliminaries: Notation and Terminology, Some Complex Analysis, Some Linear Algebra, Finite-Dimensional Eigenvalue Perturbation Theory, Some Results from Real Analysis. Operator Basics: Topologies and Special Classes of Operators, The Spectrum, The Analytic Functional Calculus, The Square Root Lemma and the Polar Decomposition.

15 Lectures

Unit II: Compact Operators, Mainly on a Hilbert Space: Compact Operator Basics, The Hilbert-Schmidt Theorem, The Riesz-Schauder Theorem, Ringrose Structure Theorems, Singular Values and the Canonical Decomposition, The Trace and Trace Class, Trace Ideals,

15 Lectures

Unit III: Hilbert–Schmidt Operators, Schur Bases and the Schur-Lalesco-Weyl Inequality, Determinants and Fredholm Theory, Operators with Continuous Integral Kernels, Lidskii's Theorem, Regularized Determinants, Weyl's Invariance Theorem, Fredholm Operators and their Index, M. Riesz's Criterion.

15 Lectures

Unit IV: Orthogonal Polynomials: Orthogonal Polynomials on the Real Line and Favard's Theorem, The Bochner–Brenke Theorem, L^2- and L^∞-Variational Principles: Chebyshev Polynomials, Orthogonal Polynomials on the Unit Circle: Verblunsky's and Szeg″o's Theorems.

15 Lectures

Recommended Book:

1. Barry Simon, Operator Theory-A Comprehensive Course in Analysis- Part 4, American Mathematical Society, Providence, Rhode Island , 2015.

Reference Books:

1. John B. Conway, A course in Operator Theory, (Graduate Studies in Mathematics, Vol. 21) American Mathematical Society, Providence, Rhode Island , 1999
2. John B. Conway, A Course in Functional Analysis, Second Edition, Springer-Verlag, New York 1990.
3. Walter Rudin, Functional Analysis , Second Edition, McGraw-Hill, 1990.
4. Balmohan V. Limaye, Functional analysis, New Age International, New Delhi, 1996.

NEW/REVISED SYLLABUS FOR
M. Phil. / Ph.D. Course Work
Paper: III
Title of Paper: Theory of Fractional Dynamic Systems

Unit I: A Short History and Some Related Functions, The R-L Fractional Integrals and Derivatives, The Grunwald-Letnikov Derivative, The Caputo Derivative, The Mean Value Theorem, Dini Derivatives and Comparison Theorems, The Volterra fractional integral inequalities, Fractional Differential inequalities Local Existence and Extremal Solutions, Existence, Uniqueness and Continuous Dependence.

15 Lectures

Unit II: Approximate Solutions and Global Existence, Linear Fractional Differential Equations, Finite Systems of Differential Inequalities, Existence of an Euler Solution, Caputo's Fractional Differential Equation,Theoretical Approximations-Theoretical and Constructive Existence Result, Generalized Monotone Iterative Technique, Monotone Method for PBVP, Generalized Monotone Iterative Technique- PBVP. **15 Lectures**

Unit III: Quasilinearization,Generalized Quasilinearization, Stability Criteria,Proximal Normal and Flow Invariance,Relation Between Fractional and Ordinary DEs, Lyapunov Theory -Basic Comparison Result, Stability Criteria,Stability Concepts in Terms of Two Measures,Stability Criteria in Terms of Two Measures,Boundedness and Lagrange Stability. **15 Lectures**

Unit IV: Several Lyapunov Functions,Multi-Order Fractional Differential Systems, Stability of Multi-Order Systems via ODEs, Fractional Functional DEs, Fractional DEs Involving Causal Operators, and Fractional DEs in a Banach space, Nonlocal Boundary Value Problems, BVP for Fractional Differential Inclusions, Almost Automorphic Solutions of Evolution Equations.

15 Lectures

Recommended Book(s):

1. V. Lakshmikantham, S. Leela and J. Vasundhara Devi, Theory of Fractional Dynamic Systems, Cambridge Scientific Publishers, UK, 2009.

Reference Books:

1. Igor Podlubny, Fractional differential equations. San Diego: Academic Press; 1999.
2. A. Kilbas, H.M. Srivastava, J.J. Trujillo, Theory and Applications of Fractional Differential Equations, Elsevier, Amsterdam, 2006.
3. Kai Diethelm, The Analysis of Fractional Differential Equations, Springer, 2010.
4. L. Debnath, D. Bhatt, Integral Transforms and Their Applications, CRC Press, 2010.

NEW/REVISED SYLLABUS FOR
M. Phil. / Ph.D. Course Work
Paper: III
Title of Paper: Differential and Integral Inequalities

Unit I: Existence and continuation of solutions, Scalar differential inequalities, Maximal and minimal solutions, Comparison theorems, Finite systems of differential inequalities, Minimax solutions, Integral inequalities reducible to differential inequalities, Differential inequalities in the sense of Caratheodory **15 Lectures**

Unit II: Global existence, Uniqueness, convergence of successive approximations, Chaplygin's method, Dependence on initial conditions and parameters, Variation of constants, Upper and lower bounds, Componentwise bounds, Asymptotic equilibrium, Asymptotic equivalence. Stability criteria, Asymptotic behavior **15 Lectures**

Unit III: The inequalities of Gronwall and Bellman, Some generalizations of the Gronwall-Bellman inequality, Volterra-type integral inequalities, The inequalities of Gamidov and Rodrigues, Simultaneous inequalities, Pachpatte's inequalities, Integro-differential inequalities, Applications-Second order integro-differential equations, Perturbation of Volterra integral equations, Higher order integro-differential equations **15 Lectures**

Unit IV: Nonlinear integral inequalities-Inequalities involving comparison, The inequalities of Bihari and Langenhop, Generalizations of Gronwall- Bellman- Bihari inequalities, Inequalities with Volterra-type kernels, Inequalities with nonlinearities in the integral, Pachpatte's inequalities I, Pachpatte's inequalities II, Integro-differential inequalities, Applications-Second order nonlinear differential equations, Perturbed integro-differential equations **15 Lectures**

Recommended Book(s):

1. V. Lakshmikantham, S. Leela, Differential and integral inequalities -Theory and applications, *Vol-I, Accademic Press, New York London, 1969.*
2. B. G. Pachpatte, Inequalities for differential and integral equations, *Accademic Press, London ,1998.*

Reference Books:

1. E. A. Coddington and N. Levinson, Theory of Ordinary Differential Equations, Tata McGraw-Hill, 1955.
2. B. G. Pachpatte, Integral And Finite Difference Inequalities and Applications, North-Holland Mathematics Studies 205, 2006
3. M. Hirsch, S. Smale and R. L. Devaney, Differential equations, dynamical systems and an introduction to chaos, Elsevier Academic Press, USA, 2004.
4. S. G. Deo, V. Lakshmikantham, V. Raghvendra, Textbook of Ordinary Differential Equations, Tata McGraw-Hill, 1997.

REVISED SYLLABUS FOR
M. Phil. / Ph.D. Course Work

Paper: III
Title of Paper: Delay Differential Equations

Unit I: Linear differential difference equations: Differential and difference equations, Retarded differential difference equations, Exponential estimates, The characteristic equation,The fundamental solution, The variation-of-constants formula, Neutral differential difference equations.
Retarded functional differential equations: Definition, Existence, uniqueness, and continuous dependence, Continuation of solutions, Differentiability of solutions. **15 Lectures**

Unit II: Stability theory: Definitions, The method of Liapunov functionals, Liapunov functionals for autonomous systems
Nonlinear Delay Differential Equations, Salient Features of Chaotic Time-Delay Systems, Linear Stability Analysis **15 Lectures**

Unit III: A Geometric Approach to Study Stability, A General Approach to Determine Linear Stability of Equilibrium Points.
Bifurcation and Chaos in Time-Delayed Piecewise Linear Dynamical System: Simple Scalar First Order Piecewise Linear DDE, Numerical Study of the Single Scalar Piecewise Linear Time-Delay System **15 Lectures**

Unit IV: A Few Other Interesting Chaotic Delay Differential Equations: The Mackey-Glass System, Ikeda Time-Delay System, Scalar Time-Delay System with Polynomial Nonlinearity, Scalar Time-Delay System with Other Piecewise Linear Nonlinearities, Time-Delayed Chua's Circuit **15 Lectures**

Recommended Book(s):

1. Hale, Jack K., Theory of functional differential equations, Springer-Verlag Berlin Heidelberg 1928
2. M. Lakshmanan, D.V. Senthilkumar, Dynamics of Nonlinear Time-Delay Systems, Springer-Verlag Berlin Heidelberg 2010.

Reference Books:

1. Hal Smith, An Introduction to Delay Differential Equations with Sciences Applications to the Life, Springer New York, 2011.

NEW/REVISED SYLLABUS FOR
M. Phil./Pre Ph. D
(Introduced from June 2017 onwards)
Paper - III
Iterative Methods

Unit I: Adomian Decomposition Method (ADM): The ADM for solving differential equations, convergence of ADM, ADM in several dimensions, Solving boundary value problems using ADM. (**15 Lectures**)

Unit II: Modified ADM, Mathematica code of ADM.
Daftardar-Gejji and Jafar Method (DJM): The DJM for solving nonlinear equations, convergence of DJM, comparison of ADM and DJM, Applications of DJM for generating new numerical methods for solving algebraic equations and differential equations, Mathematica code of DJM. (**15 Lectures**)

Unit III: Homotopy Perturbation Method (HPM): The HPM algorithm, convergence analysis, applications.
Homotopy Analysis Method (HAM): The HAM algorithm, convergence analysis, the role of auxiliary parameter, control of convergence, relation to ADM and HPM. (**15 Lectures**)

Unit IV: Applications of HAM to solve nonlinear equations.
Variational Iteration Method (VIM): The VIM algorithm, convergence of VIM, applications to solve ordinary differential equations**.**
Solving system of fractional differential equations using ADM**.** (**15 Lectures**)

References:

1. G. Adomian, Solving frontier problems in Physics: The decomposition method, Kluwer Academic Publishers, London, 1994.
2. K Abbaoui and Y Cherruault, Convergence of Adomian's method applied to differential equations, Math Comput Model, 28 (5) (1994), 103-109.
3. A. M. Wazwaz, A reliable modification of Adomian decomposition method, Applied Mathematics and Computation, 102(1) (1999), 77-86.
4. V. Daftardar-Gejji and H. Jafari, An iterative method for solving nonlinear functional equations, Journal of Mathematical Analysis and Applications, 316(2) (2006), 753-763.
5. S. Bhalekar and V. Daftardar-Gejji, Convergence of the new iterative method, International Journal of Differential Equations, 2011 (2011).
6. K. Noor and M. Noor, Iterative methods with fourth-order convergence for nonlinear equations, Applied Mathematics and Computation, 189 (1) (2007), 221–227.
7. V. Daftardar-Gejji, Y. Sukale and S. Bhalekar, A new predictor-corrector method for fractional differential equations, Applied Mathematics and Computation, 244 (2) (2014), 158–182.
8. J. H. He, Homotopy perturbation method: a new nonlinear analytical technique, Applied Mathematics and computation, 135(1) (2003), 73-79.
9. Z. Ayati and J. Biazar, On the convergence of Homotopy perturbation method, Journal of the Egyptian Mathematical Society, 23(2) (2015), 424-428.
9. S. Liao, Beyond perturbation: introduction to the homotopy analysis method, CRC press, 2003.
10. J. H. He, Variational iteration method–a kind of non-linear analytical technique: some examples, International journal of non-linear mechanics, 34(4) (1999), 699-708.
11. Z. Odibat, A study on the convergence of variational iteration method, Mathematical and Computer Modelling, 51(9) (2010), 1181-1192.
12. J. H. He, Variational iteration method for autonomous ordinary differential systems, Applied Mathematics and Computation, 114(2) (2000), 115-123.
13. V. Daftardar-Gejji and H. Jafari, Adomian decomposition: a tool for solving a system of fractional differential equations, Journal of Mathematical Analysis and Applications, 301(2) (2005), 508-

Revised syllabus For
M.Phil/Ph.D. Course work
Paper :III
Title of paper: Atomistic and Multiplicative Lattices

UNIT I :

Lattices, modular lattices, distributive lattices, Boolen Algebra product of lattices.

(No of Lectures 15)

UNIT II:

Symmetric Lattice and basic Propeties of lattices:Modularity in Lattices Semi-orthogonality in lattices, orthogonality in lattices in Symmetric Lattices, Distributivity and the Center of a Lattice,ceter of Complete Lattices, Perspectivity and projectivity in Lattices. (No of Lectures 15)

UNIT III:

Atomistic Lattices and the Covering Property:The Covering Property in Atomistic Lattices, Atomistic Lattices with the Covering Property, Finite-Modular AC-Lattices, Distribuvity and Perspecctivity in Atomistic Lattices, Perspecctivity in AC- Lattices, Completion by cuts. (No of Lectures 15)

UNIT IV:

Multiplicative Lattices :Definition Principal , Quotients Lattices, Noetherian Lattices (No of Lectures 15)

V) Recommended Reading

a) Basic Reading:

1: Theory of Symmetric Lattices, F.Maeda and S. Maeda,Spriinger-Verlag,1970
2: Theory of Lattices and pro. Of Lattices Graters
3: Abstrol theory of by R.P Dilwaorth Pacific Jorunal vol.

b) Additional Readings: -

c) References

i) Books: -

ii) Periodicals / Journals: -

NEW/REVISED SYLLABUS FOR
M. Phil. / Ph.D. Course Work

(i) Paper - M. Phil. Paper III

ii) Title of Paper: Generalized Integral Transformations

(iii) Specific Objectives: The objective of the paper is to introduce Frechet spaces and different spaces of distributions, or Generalized functions. In this course students will be acquainted with Laplace, Mellin and finite integral transforms on spaces of distributions and applications

(iv) UNITS:

Unit I:

Multinormed Spaces, Countable-Union Spaces, Duals of Countably Multinormed Spaces, Duals of Countable-Union Spaces, operators and Adjoint Operators, The Spaces $D(I)$, and Their Duals; Distributions, The Space $E(I)$ and Its Dual; Distributions of compact , Support, Generalized Functions (No of Lectures 15)

Unit II: The Testing-Function Spaces $L_{a,b}$ and $L(w, z)$ and Their Duals, The two-sided Laplace Transformation, Operation- Transform Formulas, Inversion and Uniqueness An Operational Calculus, convolution, the Laplace Transformation of Convolution, The Cauchy Problem for the Wave equation in One-Dimensional Space. (No of Lectures 15)

Unit III: The testing function spaces $M_{a,b}$ and $M(w, z)$ and their duals, the Mellin transformation, operation transform formulae, Operational Calculus for Euler differential equations. (No of Lectures 15)

Unit IV: The Testing-Function Spaces A , Generalized Functions Space A', Orthonormal Series Expansions and Generalized Integral Transformations, Characterizations of the Generalized Functions in A' and their Transforms, An Operational Calculus for the operator R . (No of Lectures 15)

(v) Recommended Reading :

a) Basic Reading:- Zemanian A.H.: Generalized Integral Transformations, John-Wiley & Sons(1968).

b) Additional Reading: Pathak R.S.: Course in Distribution Theory & Applications, Narosa (2001).

c) References

i) Books:

1) Al-Gwaiz M.A., Theory of Distributions, Marcel-Dekker (1992).
2) Kanwal R.P., Generalized Functions; Theory & Techniques, Academic Press (1983).
3) Keshavan S.: Topics in Functional Analysis & Applications, Wiley Eastern

ii) Periodicals / Journals: -

NEW/REVISED SYLLABUS FOR
M. Phil. / Ph.D. Course Work

(i) Paper - III
(ii) Title of paper - Trellis Theory
(iii) Specific Objectives - In this course student will be acquainted with concepts of Trellis theory.

(iv) UNITS:

UNIT -I :

- Pseudo-ordered Sets
- Trellises
  Complete Trellises (No of Lectures 15)
-
- UNIT-II :
- Transitive and Associative Elements
- Distributive Elements
  Standard Elements (No of Lectures 15)
- UNIT-III :
  Modular Trellises (No of Lectures 15)
- UNIT-IV :
- Boolean Lattices
- Mappings
- Ideals
  Trellis Groups (No of Lectures 15)

(v) Recommended Readings:

a) Basic Reading :

1. Skala H.L., Trellis theory, American Mathematical Society, Providence, R. I., 1972.

b) Additional Reading : -

c) References :

i) Books:

1. Gratzer G.: Lattice Theory – First Concepts and Distributive Lattices.
2. Birkhoff G.: Lattice Theory, (American Mathematical Society, Providence, Rhose Island, (1967) Colloquium Publications, 25.

ii) Periodicals / Journals: -

NEW/REVISED SYLLABUS FOR
M. Phil. / Ph.D. Course Work

(i) Paper - III
(ii) Title of paper -Commutative Algebra
(iii) Specific Objectives: In this course student will be acquainted with concepts of Commutative Algebra.
(iv) UNITS:

Unit – I : Minimal Prime and Primary Ideals : Examples and properties of Minimal, Prime and Primary Ideals. The nil radical of an ideal and its properties, semiprime ideals. The associated prime ideal of a primary ideal, Problems. (No of Lectures 15)

Unit – II: Minimal prime ideals of a ring.Certain Radicals of a Ring : Jacobson Radical, The definition of the idempotents of R/I can be raised or lifted into R and its properties, Primary rings, Problems. (No of Lectures 15)

Unit – III: Quasiregular element and its properties, Prime radicals, Modular ideals, Jradial of a ring. Boolean rings, Regular rings, Stone representation theorem. Direct sumof Rings, Problems. (No of Lectures 15)

Unit – IV: Birkhoff theorem , Rings with Chain conditions: Equivalence of three conditions of a ring with a.c.c., Hilbert Basis Theorem, Levitsky Theorem, Wedderburn Theorem, Problems. (No of Lectures 15)

(v) Recommended Reading:

a) Basic Reading:

1. Barton David M. : A first course in Rings and Ideals Addison Wesley Publishing Company 1970.
2. Oscar Zoriskiand P. Samuel : Commutative Algebra, Vol.I, Affilioted East Press Pvt. Ltd., New Delhi.

b) Additional Readings: -

c) References:

i) Books:

1. M.Atiyah and I.C. McDonald : Commutative Algebra.
2. Motsumura : Commutative Algebra.

ii) Periodicals / Journals: -

NEW/REVISED SYLLABUS FOR
M. Phil. / Ph.D. Course Work

(i) Paper : III
(ii) Title of paper : Theory of Near Rings
(iii) Specific Objectives: In this course student will be acquainted with concepts of Near Rings.
(iv) UNITS:

Unit – I : Definition and properties of N – groups and substructures Homomorphism and Ideals. Annihilators. Near Rings of quotients. Products and direct products. Embedding in M(Γ). (No of Lectures 15)

Unit – II: Chain conditions. Prime ideals, semi-prime ideals, Nil and Nilpotent ideals. Idempotent elements. (No of Lectures 15)

Unit – III: Distributively generated Near Rings. Construction of distributively generated Near Rings. Distributively generated Near Rings with finiteness conditions. Polynomial Near Rings. (No of Lectures 15)

Unit – IV: Near fields. Conditions to be a Near field. The additive group of a Near field. The center and Kernel of a Near field. Dikson Near fields. (No of Lectures 15)

(v) Recommended Reading:

a) Basic Reading

1. Guntur Pilz: Near Rings, North Holland Publishing Company, Revised Edition 1983.

b) Additional Readings: -
c) References :
i) Books: -
ii) Periodicals / Journals: -

NEW/REVISED SYLLABUS FOR
M. Phil. / Ph.D. Course Work

(i) Paper - III
(ii) Title of Paper: Topics in General Relativity
(iii) Specific Objectives: Students will be exposed to some Mathematical techniques to understand the nature and to solve the real world problems.

(iv) UNITS :

Unit: I

Killing vector fields, Isometry. Necessary and sufficient conditions for isometry. Homogeneity and isometry. Maximally symmetric space-time. Einstein space. The action principle, the energy momentum tensor. The stress energy momentum tensor for perfect fluid, electromagnetic field. Einstein's field equations from action principle and its
Newtonian approximation. Flat space and empty space. Local conservation laws associated with perfect fluid distribution. (No of Lectures 15)

Unit: II

Schwarzschild space-time. Spherical symmetry. Einstein field equations under spherical symmetry. Schwarzschild exterior solution. Isotropic co-ordinates. Retarded time. Isotropic form of Schwarzschild exterior solution. Tetrad Formalism, Covariant differentiation, Ricci's rotation coefficients, Cartan's equations of Structure, Bianchi identities, Lie derivative, Calculation of connection 1-forms and curvature 2-forms for Vaidya's metric, Godel metric and spherically symmetric space times.

(No of Lectures 15)

Unit: III

Geometry of the expanding universe, space of constant curvature, space of negative curvature, Einstein Universe, De Sitter Universe. A non isotropic model. Properties of Einstein and De Sitter Universe The linearized field equations. The Weyl solution to
linearized field equations. Associated Weyl solutions. Structure of the linearized equations. Static spherically symmetric solution of linearized field equations.

(No of Lectures 15)

Unit: IV

Four velocity of the fluid. Decomposition of the 4 velocity of a fluid u_i in terms of acceleration, rotation, shear and expansion. Isentropic flow. Raychaudhari equation. Geodesic flow with shear and expansion, Equation of motion, stress energy tensor of a mass less scalar field and perfect fluid. Maxwell equations, Generalization of Maxwell's equations. Invariance of Maxwell's equations under conformal transformations.

(No of Lectures 15)

(v) Recommended Reading: **a)**

Basic Reading :

1. R. Adler, M. Bazin and M. Schiffer: Introduction to General Relativity, McGraw-Hill

2. J.V. Narlikar: Lectures on General Relativity and Cosmology. The Mac Millan com.(1978).
3. A. P. Lightman, W. H. Press, R. H. Price and S. A. Teukolsky: Problem Book in Relativity and Gravitation, Princeton University Press, (1975).

b) Additional Readings:
c) References :
i) Books: -
ii) Periodicals / Journals: -

NEW/REVISED SYLLABUS FOR
M. Phil. / Ph.D. Course Work

(i) Paper: III
(ii) Title of paper: Theory of Choice
(iii) Specific Objectives: Introduction to choice mathematically.
(iv) UNITS:

Unit I Preliminaries: The concept of choice, Examples of choice problems in economics. Ordering relation, Mapping and Correspondences, Maximal elements and greatest elements, Utility functions. The axioms of preference model, Revealed preference, Favorability and revealed favorability, The logical significance of the preference model. (No of Lectures 15)

Unit II: A choice function model, The connection between the choice function model and the preference model, some implications of the choice function model.

Unit III: Introduction, sets in real Euclidean space, c.u.p. sets, Theorem on c.u.p. sets, Properties of real valued functions (No of Lectures 15)

Unit IV: The axioms of the consumer preference model, the utility function, the demand function and its connection with choice function, preference sets, Duality in consumer choice theory, Preordering of the price space and the dual utility function, Demand functions, price functions and revealed preference relations.

(No of Lectures 15)

(V) Recommended Reading:

a) **Basic Reading**:
Axiomatic Choice Models, H. N. Weddepohl, Rotterdam University Press, Netherlands 1970

b) **Additional Reading**: Social Choice and Individual values Edn. 2, Arrow K. J., John Willey and Son's, New York- 1963

c) **References**:

i) Books:
Handbook of Mathematical Economics- vol.1, Arrow K. J. and Intriligator, Amsterdam, north-Holland 1981

i) Periodicals / Journals: -

NEW/REVISED SYLLABUS FOR
M. Phil. / Ph.D. Course Work

(i) Paper: III
(ii) Title of paper: Theory of Fuzzy Computation
(iii) Specific Objectives: Insight in to fuzzy computation and problem extraction for research.
(v) UNITS:

Unit I: Max-min automata, General formulation of automata, Classes of automata, Behavior of Max-min automata, Equivalence and homomorphism of max-min automata.

(No of Lectures 15)

Unit II: Reduction of max-min automata, Definite max-min automata, Reduction of max-min machines, Equivalences, Irreducibility and minimality, Determinism and non-determinism of max-min automata. (No of Lectures 15)

Unit III: Max-product machines, Equivalences, Irreducibility and minimality, Max-product grammars and languages, Weak regular max-product grammars and languages.

(No of Lectures 15)

Unit IV: Fuzzy languages, Types of grammars, Fuzzy context-free grammars, Context-free max-product grammars, Context-free fuzzy languages, Meaning of context-free languages.

(No of Lectures 15)

(V) Recommended Reading:

a) **Basic Reading**:

Fuzzy Automata and Languages: Theory and Applications, J. N. Mordeson and D. S. Malik, Champan and Hall / CRS Press, New York 2002.

b) Additional Reading:

Fuzzy Relational Calculus: Theory, Applications and Softwares, Ketty P. and Yordan K., World Scientific, New Jersey, 2004.

c) References:

i) Books :

Introduction to Automata Theory, Languages and Computation, Hopcroft J. E and Ullman J. D., Narosa Publishing House, New Delhi 1993.

ii) Periodicals / Journals: -

NEW/REVISED SYLLABUS FOR

M. Phil./Pre Ph.D. in Mathematics

(i) Paper - III

ii) Title of Paper: **Lattices Theory**

(iii)Specific Objectives: In this course student will be acquainted with concepts of Lattices Theory

(iv) UNITS:

Unit :1

Types of lattices:- Posets, Isomorphism , Graded Poset, Lattices, Lattices Algebra, Distributivity, Semimodularity, Boolean Lattices, Boolean Algebra, Quasi-ordering, Lattice Postulates, Semi lattices, Morphisms and ideals, Congruence Relations,
Modularity, Brouwerian Lattices. (No of Lectures 15)

Unit: 2

Complete Lattice:- Closure Operation , Ideal Lattices , Fix point Theorem, Topological closure , Infinite Distributivity , Lattices with Unique Complements, Complete
Brouwerian Lattices , Theorem of Glivenko. (No of Lectures 15)

Unit: 3

Application of Lattice Theory to Algebra :- Modules; Group with Operators ,Permutable congruence , Direct decompositions, Kurosh-Ore Theorem , Theorem of Ore , Subgroup
Lattices, Modular Subgroup Lattices. (No of Lectures 15)

Unit: 4

Application of Lattice Theory to General Topology :- Properties of the lattices of all open sets and lattices of all closed sets of given topological space , T1 – lattices , Bases and Sub bases ; Compactness , Alexander and Tychonoff Theorem , Wallman Theorem , Metric lattices ,
Valuation on lattice , Distribution valuation . (No of Lectures 15)

Recommended Reading:

a) Basic Reading:

1) Gratzer G :Lattice Theory – First concepts and Distributivity lattices.
2) Birkhoff G : Lattice Theory , (American Mathematical Society,Providence, Rhose Island) Colloquium Publications , Volume 25.

b) Additional Reading: -

c) References: -

i) Books: -

ii) Periodicals / Journals: -

NEW/REVISED SYLLABUS FOR
M. Phil./Ph.D. Course Work

(i) Paper : III

(ii) Title of Paper : Topics in Geometric Function Theory

(iii) Specific Objectives: In this course student will be acquainted with concepts of Geometric Function Theory. This is a branch of Complex Analysis with sustained interest for several years.

(iv) UNITS:

UNIT: I

Schwarz's Lemma, Montel's Theorem, Green's Theorem on Harmonic functions, Univalent functions, Koebe Functions, Area theorem, Growth and distortion theorems.

(No of Lectures 15)

UNIT: II

Brief history of D'Branges theorem, Littlewood's theorem, Convex, starlike functions, Alexander's theorem, Close to convex functions, Noshiro-Warchawski's theorem, Kaplan's theorem. (No of Lectures 15)

UNIT III

Spirallike functions, Radius of starlikeness, convexity and close to convexity, Differential subordination, Hypergeometric functions, Ruscheweyh derivative operator, convolution (Hadamard product). (No of Lectures 15)

UNIT IV

Extreme points, Herglotz' representation, meromorphic univalent functions, Harmonic univalent functions, Fractional derivatives, coefficient inequalities, closure property.

(No of Lectures 15)

Reference Reading:

a) Basic Reading:

1. P.L.Duren: Univalent Functions, Springer-Verlag, New York, Berlin, Heidelberg,1983
2. S. S. Miller and P. T. Mokano: Differential Subordinations, Mercel Dekkar, Inc., New York, Basel, Hong-Kong.

b) Additional Readings: -

c) References:

i) Books: -

ii) Periodicals / Journals : -

NEW/REVISED SYLLABUS FOR
M. Phil./ Ph. D. Course Work

i) **Paper : III**
ii) Title of Paper : Fluid Dynamics
(iii) Specific Objectives:
(iv) A brief note: - (Notations and concepts are taken from books given in basic reading; this should be taken in account for examination point of view).
(v) UNITS:

Unit- I :- INDRODUTION AND PHYSICAL PROPERTIES OF FLUD

Concepts of fluids, types of fluid, continuum hypothesis, Physical properties of fluid: Density, specific weight, Specific volume, Pressure, Viscosity and surface tension, Compressibility and Bulk modulus, vapour pressure and examples. (No of Lectures 15)

UNIT- II :- KINEMATICS OF FLUID

Basic concepts, Eulerian and Lagrangian methods for description fluid motion, steady and unsteady motion, stream line motion and turbulent motion, uniform and non-uniform motion rotational and irrotational motion , stream line, path line, streak line, velocity potential , stream function, vorticity vector, Equation of continuity, equation of continuity by Eulerian and Lagragian methods, equation of continuity in different co-ordinates, Velocity and acceleration of fluid particle. (No of Lectures 15)

UNIT- III:- EQUATION OF MOTION

Euler's equation motion, pressure equation, Bernoulli's , equation Cauchy's integrals. Equation for impulsive action, example. Flows and circulation, Kelvin's Circulation theorem, Helmholtzs Vorticity equation. (No of Lectures 15)

UNIT –IV :-MAGNETTHOHYDRODYNAMICS

Nature of Magnetohy drodynamics, Maxwell's electromagnetic field equations: Medium at rest, Maxwell's electromagnetic field equations: Medium at motion , the equations of motion of a conducting fluid, rate of flow of charge, simplification of electromagnetic field equations. Electromagnetic waves. (No of Lectures 15)

(v) Recommended Reading:
a) Basic Reading:
1. A textbook of Fluid Dynamics by F.Chorlton. CBS publishers & Distributors, Delhi.
2. Fluid Dynamics by Dr .J. K. Goyal & K. P. Gupta, Pragati Prakashan.

b) Additional Readings: -
c) References:
i) Books:
1. A textbook of Fluid Dynamics by R. k. Rajput, S. Chand & Company LMD. Ram Nagar, New Delhi.
2. Fluid Dynamics by A. K. Jain, Khanna Pub. ,Delhi.
3. Streeter, McGraw-Hill International Co. Auckland.
4. Fluid Dynamics by White.
5. Fluid Dynamics by Arora.

ii) Periodicals / Journals : -

NEW/REVISED SYLLABUS FOR

M. Phil./ Ph.D. Course Work

(i) Paper: **III**

(ii) Title of Paper: **Fuzzy Measures and Integrals**

(iii) Specific Objectives: In this course student will be acquainted with concepts of Fuzzy Relations, Fuzzy Logic, Fuzzy Measures and Fuzzy Integrals.

(iv) UNITS:

UNIT I: FUZZY RELATIONS:

Projections and cylindrical Extensions Binary Fuzzy Relations on single set, Fuzzy equivalence relations, Fuzzy Compatibility Relations, Fuzzy ordering Relations Fuzzy morphisms SUP-I compositions and inf-wi compositions .fuzzy Relation Equation

:Problem Partitioning, solution methods, Fuzzy relational equations based on sup-I and inf-wi compositions, Approximate solutions . (No of Lectures 15)

UNIT II: FUZZY LOGIC:

Fuzzy propositions. Fuzzy Quantifiers, Linguistic Hedges, Inference from conditional fuzzy propositions, Qualified and quantified propositions. Approximate Reasoning:-Fuzzy expert systems, Fuzzy implications, selection of Fuzzy implications, Multi-conditional Approximate Reasoning, Role of fuzzy relational equations, Interval valued

Approximate Reasoning. (No of Lectures 15)

UNIT-III: FUZZY MEASURES:

Fuzzy measures, Evidence theory, possibility theory, Fuzzy sets and possibility theory, possibility theory verses probability theory Uncertainty based Information:-Information and Uncertainty, Non specificity, of crisp sets and fuzzy sets fuzzyness of fuzzy sets, uncertainty in Evidence theory, uncertainty measures, of uncertainty.

(No of Lectures 15)

UNIT-IV:

Fuzzy measures as Non additive measures, Sugeno integrals and its properties, Choquet integral, Fuzzy integrals as an aggregation oprators. Applications to multicriteria Decision Making. Choquetn expted utility model, The Choquet integral in multiattribute

decision making. (No of Lectures 15)

(v) Recommended Reading:

a) Basic Reading:

1: George J Klir, Bp yuan, Fuzzy sets and Fuzzy Logic. Theory and applications, Prentice-Hall of India. Pvd .Ltd.(2000)

2: M.Grabish, Sugeno, and Murofushi Fuzzy Measures and Integrals: theory and Applications PHI, 1999, India.

3: H.J.Zimmerermann, fuzzy set Theory and its Applications, Kluwer, 1984.

b) Additional Reading: -

c) References:

i) Books: -

ii) Periodicals / Journals: -

NEW/REVISED SYLLABUS FOR

M. Phil./ Ph.D. Course Work

(i) Paper : III

(ii) Title of Paper : Numerical Analysis III

(iii) Specific Objectives : --

(iv) UNITS:

UNIT I: Boundary value problems, shooting method, derivative boundary conditions, characteristic value problems, Alternating direction implicit method, irregular regions and nonrectangular grids. (No of Lectures 15)

UNIT II: Finite difference approximations to partial derivatives, the local truncation error, consistency and inconsistency of numerical method, convergence and analysis of approximations, Stability, Von Neumann analysis, The global rounding error.

(No of Lectures 15)

UNIT III: Parabolic partial differential equations, solution techniques for parabolic equation in one dimension, parabolic equations in two and three dimensions, finite difference methods , finite element methods for parabolic partial differential equations.

(No of Lectures 15)

UNIT IV: Hyperbolic partial differential equations, solution techniques, equations in two and three dimensions, finite element methods in hyperbolic partial differential equations.

(No of Lectures 15)

(v) Recommended Reading:

a) Basic Reading:

Gerald and Wheatley: Applied numerical analysis, sixth Edition, Pearson Education 2002

b) Additional Readings: -

c) References:

i) Books:

1) M. K. Jain: Numerical solutions of differential equations. Wiley Estern Ltd 1991.

2) G. D. Smth: Numerical Solution of Partial Differential Equations Finite Difference Methods, Third Edition, Oxford University Press.

ii) Periodicals / Journals: -

NEW/REVISED SYLLABUS FOR
M. Phil./Ph. D. Course Work

(i) Paper : III
(ii) Title of Paper : Group Analysis of Differential Equations
(iii) Specific Objectives : --

(iv) UNITS:

UNIT I:

One parameter transformation groups, local lie group, tangent vector field, Lie Equation, examples, correspondence of groups and vector fields, criterion of invariance, examples of invariants. (No of Lectures 15)

UNIT II:

Groups admitted by Differential equations, Fundamental definitions, Action on solutions, full group, Lie algebra of operators, commentators, action of mappings, algebraic properties, structural tensor, isomorphism criterion (No of Lectures 15)

UNIT III:

Full Lie group of concrete system of equations, system of first order equations, general solution analysis, structure of full Lie algebra, Higher order equations.

(No of Lectures 15)

UNIT IV:

Structural constants, homomorphism, sub algebras, Factor algebra, the radical, Levi theorem (statement only), Associated Lie algebra, algebra of differentiation, inner automorphism, Killing's form, Structural properties, Optimal sub algebraic systems, Maltsev-Harish-Chandra theorem (statement only), examples. (No of Lectures 15)

(v) Recommended Reading:

a) Basic Reading:

L.V.Osiannikov, Group analysis of differential equations Academic pres 1982.

b) Additional Readings: -

c) References:

i) Books:

1) P.J.Olver, Applications of Lie groups to differential equations, Springer Verlag, New York, 1986.
2) G.W. Bluman and J.D.Cole, Similarity methods for differential equations, Springer Verlag NY 1974.

ii) Periodicals / Journals: -

NEW/REVISED SYLLABUS FOR
M.Phil./Pre Ph.D. in Mathematics

(i) Paper - M.Phil. Paper III
ii) Title of Paper: Mathematical Modeling
(iii) Specific Objectives: The objective of the paper is to aquatint the students applications of difference and differential equations and different mathematical models.

(iv) A brief note: - (Notations and concepts are taken from books given in basic reading; this should be taken in account for examination point of view).

Unit 1: Application of first order differential equations

1.1 Growth and decay
1.2 Dynamics of Tumour Growth
1.3 Biological Growth
1.4 A problem in Epidemiology

Unit 2: Setting up first-order Differential equations from word problems

Unit 3: Difference and Differential Equation Population Growth Models

Unit4: Single Species Population Models.

Unit5: A model for the Detection of Diabetes.

Unit6: Combat Models:
6.1 Three Lanchester Combat Models.
6.2 Conventional Combat : The square Law.
6.3 Guerrilla Combat: The linear law.

Reference Books:
1) Mathematical modeling: J.N.Kapur.

2) Differential Equations and There Applications: Zafar Ahsan, Second Edition. Prentice-Hill of India. New Delhi-1100001.

3) Differential equation Models : Martin Braun,Courteny S Coleman ,Donald A Drew, Vol.1 Springer – Verlag.