

DEPARTMENT OF MATHEMATICS
Ph.D., COURSE WORK

Semester	Paper Code	Course Title	Credits	Total
Core Courses				
I	17MATR0101	Advances in Algebra	4	24
	17MATR0102	Advances in Analysis	4	
	17MATR0103	Advances in Differential Equations	4	
	17MATR0104	Research Methodology	4	
II	17MATR0205	Advances in Numerical Methods	4	
	17MATR02SX	Specific course to be prescribed by the Doctoral Committee	4	
	Seminar (3) Term Paper/Topical Research			
III Semester onwards	a) Project Planning including literature collection, finalisation of objectives and methodology		4	
	b) Field / Lab Studies, Data collection, compilation of results, statistical analysis, results and final conclusion		32	
End of Program	Synopsis and thesis submission, final viva		6	

List of courses that are candidate centric (17MATR02SX)

17MATR02S1	Mathematical Analysis
17MATR02S2	Discrete Mathematics
17MATR02S3	Mathematical Modeling
17MATR02S4	Soft Computing

Learning Objectives: To impart some advances in Commutative algebra and Extension fields.

Learning Outcomes: The learner will be able to

- understand the properties of different types of ideals;
- recognize the concept of a module and their constructions;
- understand the properties of modules of fractions;
- recognize the properties of tensor product of algebras;
- understand the Extension fields, their types and characterizations.

Unit-1: Rings and Ideals: Rings and ring homomorphisms – Ideals, Quotient rings – Zero-divisors, Nilpotent elements, Units – Prime ideals and maximal ideals – Nilradical and Jacobson radical – Operations on ideals – Extension and contraction.

Unit-2: Modules: Modules and module homomorphisms – Submodules and Quotient Modules – Operations on Submodules – Direct sum and product- Finitely Generated Modules - Exact Sequences.

Unit-3: Tensor Product of Modules – Restriction and extension of scalars – Exactness Properties of the Tensor Product – Algebras and Tensor Product of Algebras.

Unit -4: Rings and Modules of Fractions: Local Properties – Extended and Contracted Ideals in Rings of Fractions.

Unit-5: Field Theory : Basic Theory of Field Extensions - Algebraic Extensions - Splitting Fields and Algebraic Closures - Separable and Inseparable Extensions.

References:

1. M.F. Atiyah and I.G. MacDonald, An Introduction To Commutative Algebra , Addison-Wesley Series in Mathematics, 1969.
2. David S. Dummit and Richard M. Foote, Abstract Algebra, Third Edition, John Wiley & Sons, Inc. , 2004.
3. Arthur Allen Altman and Steven Kleiman, A Term of Commutative Algebra, Worldwide Center of Mathematics, 2013.
4. H. Matsumura, Commutative ring theory, Cambridge Studies in Advanced Mathematics, Cambridge University Press, 1986
5. Steven Roman, Field theory, Springer Science & Business Media, 2005.

6. A. V. Jayanthan, Introduction to Commutative Algebra, NPTEL Courses,
<http://nptel.ac.in/courses/111106098/>
7. Jugal K. Verma, , Algebra II, NPTEL Courses, <http://nptel.ac.in/courses/111101001/>
8. Sudhir R. Ghorpade, Lectures on Commutative Algebra,
http://www.math.iitb.ac.in/~srg/Lecnotes/afspune_des.html

Methods of teaching to be adopted: Classroom teaching, Assignment, invited lecture.

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Unit-1: Compact Operators: Some characterizations – Space of compact operators – Further properties.

Unit-2: Spectral Results for Banach Space Operators : Eigen spectrum and approximate Eigen spectrum.

Unit-3: Spectrum and resolvent set: Spectral radius – Spectral mapping theorem –More results based on resolvent.

Unit-4: Operators on Hilbert spaces: Adjoint of an operator – Compactness of the adjoint operator – Sesquilinear functionals – Integration of operator-valued functions revisited.

Unit-5: Complete Metric Spaces and Function Spaces : Complete metric spaces - A Space Filling curve - Compactness in metric spaces

References:

1. M. Thamban Nair, Functional Analysis- A First Course, Prentice Hall of India Private Limited, New Delhi, 2008.
2. James R. Munkres, Topology, Second edition, PHI Learning Limited, New Delhi, 2012.
3. C. Goffman and G. Pedrick, First Course in Functional Analysis, Prentice-Hall of India, New Delhi, 1995.
4. B. V. Limaye, Functional Analysis, Wiley Eastern, New Delhi, 1981.
5. S. Willard, General Topology, Addison-Wesley Publishing Company, Inc., Reading, Mass, 1970.

6. C. Wayne Patty, Foundations of Topology, Jones and Bartlett Publishers, 2009.
7. Richard Melrose, Introduction to functional Analysis, MIT OpenCourseWare, <https://ocw.mit.edu/courses/mathematics/18-102-introduction-to-functional-analysis-spring-2009/lecture-notes/>
8. P. Veeramani, Topology, NPTEL Courses, <http://nptel.ac.in/courses/111106054/1>

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Unit -1: First and second order Linear Equations: First order Equations– Exact Differential Equations – Second order linear equations –Partial differential equations and ODE.

Unit -2: General theory of initial value problems: Introduction– Sufficient condition for uniqueness of solution– Sufficient condition for existence of solution –Continuous dependence of the solution on initial data and dynamics – Continuation of a solution into larger intervals and maximal interval of existence – Existence and uniqueness of a system of equations.

Unit-3: Linear systems and qualitative analysis: General n^{th} order equations and linear systems – Autonomous homogeneous systems – Two-dimensional systems – Stability analysis – Higher dimensional systems – Invariant subspaces under the flow e^{tA} – Non-homogeneous, Autonomous systems.

Unit-4: Qualitative theory: Introduction – General definitions and results – Lyapunov stability, Lyapunov function – Invariant subspaces and manifolds – Phase plane analysis – Periodic orbits.

Unit-5: Two point boundary value problems: Introduction – Linear problems – General second order equations.

References:

1. A. K. Nandakumar, P. S. Datti& Raju K. George, Ordinary differential equations: Principles and Applications, Cambridge University Press, 2017.
2. Website: <http://nptel.ac.in/syllabus/111108081/>
3. Lawrence Perko, Differential Equations and Dynamical systems, Springer-Verlag, New-York, 2001.

4. Chi Y. Lo, Boundary Value Problems, Allied-Publishers Pvt Ltd, New Delhi, 2003
5. E. A. Coddington and N. Levinson, Theory of ordinary Differential Equations, Tata-McGraw Hill, 1972.
6. M. W. Hirsch, S. Smale and R. L. Devaney, Differential Equations, Dynamical Systems & An Introduction to Chaos, Academic Press, 2004.
7. E. L. Ince, Ordinary Differential Equations, Dover, 1956.
8. S. Lefschetz, Differential Equations: Geometric Theory, Dover, 1977.
9. G. F. Simmons, Differential Equations with Applications and Historical Notes, Tata-McGraw Hill, 1991.
10. G. F. Simmons and S. G. Krantz, Differential Equations; Theory, Techniques and Practice, Tata-McGraw Hill, 2007.

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Unit-1: Introduction – Meaning – Objectives – Motivation – Types – Research Approache – Significance – Methodology – Research and Scientific Method – Defining the Problem – Selecting the problem – Necessity – Technique involved in defining a problem – Research Design – Meaning – Need for Research Design – Features of a good Design – Important concepts – Different Research Designs.

Unit-2: Sampling Design – Census and Sample Survey – Implications of a Sample Design – Steps in Sampling Design – Criteria of Selecting a sampling procedure – Characteristics – Types – Measurement and Scaling Techniques – Measurement in Research – Measurement Scales – Sources of Error in Measurement – Technique of Developing Measurement Tools

Unit-3: Methods of Data Collection – Collection of Primary Data – Observation Method – Interview Method – Collection of Data through Questionnaires and Schedules – Difference between Questionnaires and Schedules – Some other Methods – Collection of Secondary data – Selection of Appropriate Method.

Unit-4: Processing and Analysis of Data – Processing Operations – Some Problems in Processing – Elements/Types of Analysis – Statistics – Measures of Central Tendency, Dispersion, Skewness and Relationship – Sampling Fundamentals – Need for Sampling – Fundamental Definitions – Important Sampling Distributions

Unit-5: Interpolation and Report writing- Meaning of interpolation- why interpolation- Techniques of Interpolation- Precaution in Interpolation-Significance of Report writing- Different Steps in writing Report- Layout of the Research Report- Types of Reports- The Computer- Introduction_ The computer and computer technology- The computer system- Important Characteristics.

References:

1. C. R. Kothari, "Research Methodology Methods and Techniques", Second Edition, New age International (P) Ltd, Publishers, New Delhi, 2004
2. Ackoff, Russell., The Design of Social Research, Chicago: University of Chicago press, 1961
3. Bailey, Kenneth D., "Methods of social Research," New York, 1978.
4. Denzin, Norman, The research Act, Chicago: Aldine, 1973

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Unit-1: Solutions of Eigen – equations: Concept of Eigen-System- Polynomial Method- The Fadeev- Liverier Method- Graeff's Root Squaring Method for finding Roots of Polynomial

Unit-2: Power Method to find Eigen value and Eigen Vector- QR Iterative Method
Matrix Eigen value Problem: Power Method- Schur's and Gershgorin's Theorems-
Orthogonal Factorizations and Least –Squares Problems

Unit-3: Boundary value problems: Finite Difference Method- Functions values at End points-
Derivative conditions at End points- Shooting Method- Function values at End points-
Derivative values at end points- Shooting Method for Non-linear equations- function values
at end point- derivative values at end point- Numerical solutions of Ordinary Differential
equation- Milne's Predictor corrector method- Adams Bashforth predictor and corrector
Method

Unit-4: Two point boundary value problems- Finite Difference Method- The Linear Problem
with Dirichlet boundary conditions -The Linear problem with Non Dirichlet Boundary
Conditions- Finite Difference Method- Non linear problems- The Shooting Method –Linear
Boundary value problems

Unit-5: Numerical Solutions of Partial Differential Equations: Introduction –Difference
quotients- Geometrical representation of partial differential quotient- Classification of Partial
differential equations- Elliptic equations-Solutions to Laplace's equation by Liebmann's
iteration process- Poisson's equation and its solutions- parabolic equations- Crank Nicholson
method- Hyperbolic equations

References:

1. Numerical Computational Methods- P.B. Patil, U.P. Verma – Narosa Publishing House Pvt. Ltd, 2006
2. Numerical Analysis- Mathematics of Scientific Computing IIIrd Edition by David Kincaid and Ward Cheney, American Mathematical Society, Providence, Rhode Island, 2010
3. An Introduction to Numerical Analysis Third Edition Devi Prasad Narosa Publishing House Pvt. Ltd., 2006
4. A Friendly Introduction to Numerical Analysis by Brain Bradie Christopher Newport University, Pearson Prentice Hall, 2006
5. V.N.Vedamurthy and N.Ch.S.N.Iyengar, Numerical Methods, Vikas Publishing house, Pvt. Ltd, 1998
6. R.L.Burden and J.Douglas Faires, Numerical Analysis, Thompson Books, USA, 2005
7. Curtis. F. Gerald, Patrick & O.Wheatley, Applied Numerical Analysis, 5th Edition, Pearson Education, New Delhi, 2005

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