

Shiksha Mandal's

Bajaj College of Science, Wardha (Autonomous)

Department of Mathematics

SYLLABUS

wef 2023-24

M.Sc. (Mathematics) Part-I

Semester-I

DSC-1

Algebra

Course Specific Objectives:

1. To develop a sound understanding of algebraic structures, groups, normal groups, ideals, homomorphism and modules.
2. To develop ability in abstract algebraic reasoning using algebraic methods.
3. To develop the skills to analyze and prove algebraic theorems.
4. To acquire effective skills in presenting mathematical proofs, concepts, and ideas of algebra.

Course Learning Outcomes:

1. Student develops a deep understanding of algebraic structures, groups, normal groups, ideals, homomorphism and modules.
2. Gain ability in abstract algebraic reasoning using algebraic methods.
3. Students have the skills to analyze and prove algebraic theorems.
4. Has an effective skill in presenting mathematical proofs, concepts, and ideas of algebra.

SYLLABUS

Unit I:

Permutation Group. Normal subgroups, Quotient groups Dihedral group. Commutator group. Isomorphism Theorems. Automorphisms. Characteristic subgroup. Conjugacy and G-Sets, Cyclic Decomposition.

Unit II:

Normal Series. Solvable groups. Nilpotent groups. Cyclic decomposition of permutation group. Alternating groups. Simplicity of A_n

Unit III:

Direct product, semi-direct product of groups, infinitely generated abelian groups, Invariants of a finite abelian group, Sylows theorems. Groups of order p^2 and pq .

Unit IV:

Ideals and Homomorphisms. Sum and direct sum of ideals. Maximal and prime ideals. Nilpotent and Nil ideals. Modules. Submodules. Direct sums. R-homomorphisms and quotient modules. Completely reducible modules. Free modules.

Text Book:

Basic Abstract Algebra :Bhattacharya, Jain, and Nagpal ,Second Edition, Cambridge University Press.

Reference Books:

1. Topics in Algebra, I. N. Herstein, Second Edition, John Wiley.
2. Abstract Algebra: David S.Dummit and Richard M. Foote, John Wiley.

DSC-2

Topology

Course Specific Objectives:

1. To study and understand countability, topological spaces, closure, interior, exterior and boundary operators.
2. To acquire a thorough knowledge of advanced topics such as Connectedness, Compactness, Components, Continuous functions, Homeomorphisms, Separability.
3. Develop a deeper appreciation for the fundamental concepts and principles of topology, their applications in various mathematical disciplines, and their connections to other branches of mathematics.
4. To acquire effective skills in presenting mathematical proofs, concepts, and ideas in topology.

Course Learning Outcomes:

1. Students acquire a comprehensive understanding of countability, topological spaces, closure, interior, exterior and boundary operators.
2. Students acquire a thorough knowledge of advanced topics such as Connectedness, Compactness, Components, Continuous functions, Homeomorphisms, Separability.
3. Learners develop a deeper appreciation for the fundamental concepts and principles of topology, their applications in various mathematical disciplines, and their connections to other branches of mathematics.
4. To acquire effective skills in presenting mathematical proofs, concepts, and ideas in topology.

SYLLABUS

Unit I:

Countable and Uncountable sets. Examples and related Theorems. Cardinal Numbers and related Theorems. Topological Spaces and Examples.

Unit II:

Open sets and Limit points, Derived Sets. Closed sets and closure operators. Interior, Exterior and boundary operators. Neighbourhoods, bases and relative topologies.

Unit III:

Connected sets and components. Compact and countably compact spaces. Continuous functions and homeomorphisms, Arc wise connectivity.

Unit IV:

T_0 and T_1 -spaces, T_2 -spaces and sequences. Axioms of countability. Separability. Regular and normal spaces.

Text Book:

Foundations of General Topology: W.J. Pervin, Academic press, 1964.

Reference Books:

1. Topology: J.R. Munkres, (second edition), Prentice Hall of India, 2002.
2. Introduction to Topology and Modern Analysis: G.F. Simmons, Mc Graw Hill 1963.
3. General Topology: J.L. Kelley, Van Nostrand, 1995.
4. Introduction to general Topology: K.D. Joshi, Wiley Eastern Ltd. 1983

DSC-3

Ordinary Differential Equations

Course Specific Objectives:

1. To study and understand differential equations and their applications in various fields of science, engineering, and mathematics.
2. To acquire a thorough knowledge of advanced topics such as homogeneous and nonhomogeneous differential equations, Wronskian, Legendre and Bessel's equations Solutions to System of first order ordinary differential equations, Sturm Liouville theory.
3. Study and analyze the properties and behaviour of solutions to differential equations, including stability, existence and uniqueness of solutions
4. Apply differential equations to model and solve real-world problems in areas such as physics, biology, economics, engineering, and other scientific disciplines

Course Learning Outcomes:

1. The learners understand homogeneous and nonhomogeneous differential equations, and special type differential equations
2. Students acquire a thorough knowledge of advanced topics such as Solutions to System of first order ordinary differential equations, and its application to Central forces and planetary motion.
3. Students are able to analyze the properties and behaviour of solutions to differential equations, including stability, existence and uniqueness of solutions
4. They have enhanced problem-solving skills and the ability to think critically and creatively in formulating and solving problems involving differential equations.

SYLLABUS

Unit I:

Linear Equations with variable coefficients: Initial value problems for the homogeneous equations. Solutions of the homogeneous equations, The Wronskian and linear independence, Reduction of the order of a homogeneous equation, The non-homogeneous equations, Homogeneous equations with analytic coefficients, The Legendre equations.

Unit - II:

Linear Equations with regular singular points: The Euler equations, Second order equations with regular singular points, The Bessel equation, Regular singular points at infinity.

Unit III:

Existence and uniqueness of solutions to first order equations: The method of successive approximations, The Lipschitz condition of the successive approximation. Convergence of the successive approximation, Non-local existence of solutions, Approximations to solutions and uniqueness of solutions.

Unit IV:

Existence and Uniqueness of Solutions to System of first order ordinary differential equations: An example- Central forces and planetary motion, Some special equations, Systems as vector equations, Existence and uniqueness of solutions to systems, Existence and uniqueness for linear systems, Green's function, Sturm Liouville theory.

Text Book:

1. E.A.Coddington: An introduction to ordinary differential equations (2012), Prentice Hall of India Pvt.Ltd. New Delhi.
2. G. Birkoff and G.G.Rota: Ordinary Differential equations, John Willey and Sons
3. Mark Pinsky: Partial differential equations and boundary-value problems with applications, AMS, 3rd edition(2011).

Reference books:

1. G.F. Simmons Differential Equations with Applications and Historical note, McGraw Hill, Inc. New York. (1972)
2. E.A. Coddington and Levinson: Theory of ordinary differential equations McGraw Hill, New York(1955)
3. E.D. Rainvills :Elementary differential equations, The Macmillan company, New York. (1964)

DSC-4 Practical-1

List of Practical:

- 1) Representation of the permutations as a product of disjoint cycles
- 2) Determination of order of an element and order of a group
- 3) Determination of composition series for the group.
- 4) Investigation of simple groups.
- 5) Determination of right and left ideals of the ring.
- 6) Determination of maximal and prime ideals.
- 7) Determination of kernel of homomorphism of a ring.
- 8) Finding solution of Differential Equation using method of Reduction of order.
- 9) Finding solution of Linear Differential Equation with regular singular points.
- 10) Finding solution of Legendre's and Bessel's Differential equations.
- 11) Determination of Legendre's polynomial.
- 12) Derivation of Recurrence Relation on Bessel Function.
- 13) Determination of approximate solution of Differential Equation using successive Approximations.
- 14) Examination of Lipschitz Conditions and determination of Lipschitz constant.
- 15) Determination of Topological spaces.
- 16) Determination of Interior points, limit points, closures of a set.

DSE-1

Integral Equations

Course Specific Objectives:

1. To study and understand integral equations and integral equations and integro-differential equations
2. To acquire knowledge of Fredholm equations, kernels and Hilbert- Schmidt theorem.
3. Study and analyze the properties and behaviour of solutions to Voltera equations, Fourier integral equations. Laplace integral equations.
4. To study and understand Hilbert transform, Eigen values and Eigen functions.

Course Learning Outcomes:

1. Students understand integral equations and integral equations and integro-differential equations
2. They acquire knowledge of Fredholm equations, kernels and Hilbert- Schmidt theorem.
3. Students study and analyze the properties and behaviour of solutions to Voltera equations, Fourier integral equations. Laplace integral equations.
4. They understand and can apply Hilbert transform, Eigen values and Eigen functions to divorce problems.

SYLLABUS

Unit I:

Preliminary concepts of integral equations. Some problems which give rise to integral equations. Conversion of ordinary differential equations into integral equations. Classification of linear integral equations. Integro-differential equations.

Unit II:

Fredholm equations. Degenerate kernels. Hermitian and symmetric kernels. The Hilbert- Schmidt theorem. Hermitization and symmetrization of kernels. Solutions of integral equations with Green's function type kernels.

Unit III:

Types of Volterra equations. Resolvent kernel of Volterra equations, Convolution type kernels. Some miscellaneous types of Volterra equations. Non-linear Volterra equations. Fourier integral equations. Laplace integral equations.

Unit IV:

Hilbert transform. Finite Hilbert transforms. Miscellaneous integral transforms. Approximate methods of solutions for linear integral equations. Approximate evaluation of Eigen values and Eigen functions.

Text Book:

Integral Equations: A short course: L. G. Chambers: International text book company Ltd, 1976.

Reference books:

1. Integral equations by Shanti Swaroop, Shiv Raj Singh
2. Linear integral equation, Theory and techniques, Academic press, New York 1971
3. R.P. Kanwal, Linear Integral Equation, Theory and Techniques, Academic Press, N.Y. (1971).
4. S.G. Mikhlin, Linear Integral Equations, Hindustan Book Agency, (1960).
5. A.M. Viazwaz, A First Course in Integral Equations, World Scientific (1997).
6. L.I.G. Chambers, Integral Equation: A Short Course, International Text Book Company Ltd. (1976).
7. Larry Andrews, Bhimsen Shiramoggo, Integral Transform for Engineers, Prentice Hall of India (2003).
8. Integral equations and boundary value problems by M. D. Raisinghanian, S. Chand Publication

Research methodology

Course Objectives

1. Gain a comprehensive understanding of research methodology and its fundamental concepts.
2. Acquire skills in data collection, analysis, and interpretation using various statistical techniques.
3. Develop the ability to critically evaluate and select appropriate research methods for different types of research.
4. Enhance proficiency in technical writing, research reporting, and adherence to research ethics and academic integrity.

Course Outcomes

After learning research methodology course, students will be able to:

1. Identify and describe the characteristics of different types of research, including basic, applied, and patent-oriented research.
2. Apply descriptive and inferential statistical analysis techniques to analyze and interpret research data and its importance in research, and apply appropriate research methods.
3. Apply scientific thinking and problem identification techniques in the research process.
4. Develop skills in technical writing, research reporting, and the proper structure and organization of research documents and gain awareness of research ethics, academic integrity, and the importance of avoiding plagiarism and academic malpractice

Syllabus:

Module 1: Research basics and perception of research

1.1 Definition, General and specific characteristics of research, types of research (basic, applied and patent oriented).

1.2 Steps of Action (basic) research, objectives of basic research, characteristics of investigators.

1.3 Scientific thinking- characters, steps in process of scientific thinking, Steps in problem identification, criteria for selecting problem, and sources of scientific problems.

1.4 Review of literature- meaning, need, and objectives, structure of review of literature, sources of literature collection, Simple rules of structuring (writing) literature review.

Module 2: Statistical analysis

2.1 Errors in analysis. Classification of errors- systematic and random, additive, and proportional, absolute and relative. Accuracy and precision. Mean, median, average deviation and standard deviation.

2.2 Significant figures and rules to determine significant figures. Calculations involving significant figures.

2.3 Confidence limit, correlation coefficient and regression analysis. Comparison of methods: F-test and t-test. Rejection of data based on Q-test. Least squares method for deriving calibration graph.

2.4 Application of Microsoft Excel in statistical analysis (statistical functions and spreadsheets in MS-Excel). Certified reference materials (CRMs). Numerical problems.

Module 3: Scientific Writing and Presentation

3.1 Scientific writing. Types of scientific publications- magazines, journals, reviews, news-letters, structure of scientific paper.

3.2 Report Writing, different steps in report writing, types of reports, layout of research paper.

3.3 Research indicators & Metrics: ImpactFactor, CiteScore, h-Index, i10-Index, Citation Index, references/bibliography, structuring the thesis, use of software in thesis writing.

3.4 Intellectual Property Rights (IPR): Introduction to IPR (Patents, Trademarks, Geographical indicators, Copyright, and neighboring rights), concept and theories, kinds of IPR, Advantages and disadvantages of IPR.

Module 4: Use of tools / techniques for Research

4.1 Methods to search required information effectively, Various reference styles, Reference Management Software like Zotero/Mendeley, preparation of bibliography database.

4.2 Software/tools: MS Word, MS Excel, Graph and chart preparation, MS Power Point, OriginLab (For plotting graph).

4.3 Research ethics, Academic integrity, Plagiarism, types, detection of plagiarism using software.

Reference/Books:

- 1) Shanti Mishra, &Alok, S. (2011). Handbook of Research Methodology: A Compendium for Scholars & Researchers. Educreation Publishing.
- 2) Singh, Y. kumar. (2006). Fundamentals of Research Methodology and Statistics. New Age International Publishers.
- 3) Walliman, N. (2010). Research Methods The Basics. Routledge Taylor and Francis Group.
- 4) Research Methodology- C. R. Kothari
- 5) Best and Kahn, Research Methodology, PHI Limited
- 6) Design of Experience: Statistical Principles of Research Design and Analysis, by Robert O. Kuehl Brooks/cole.
- 7) Patrick Carey, Katherine T. Pinard, Ann Shaffer, Mark Shellman, New Perspectives Microsoft Office 365 and Office 2019 Introductory, 2020.

Assignments based on Research Methodology course

Instructions:

These assignments can enhance the professional skills needed to pursue a career in research/teaching. Therefore, each PG department should identify 10 assignments from the list below. Continuous evaluation will occur throughout the semester. Performance on the assignment will be graded for 40 marks.

1. Navigate and use Google, Google Scholar, SciHub, PubMed, Web of Science, Elicit and ScienceDirect effectively to search for research papers, perform searches and retrieve relevant research papers.
[Suggestion/Working hours:-Dedicate a few hours each week to practice searching on these databases to continually refine your skills.]
2. Write accurately references in APA format for various types of sources, including books, journal articles, websites, and conference papers and gain a comprehensive understanding of the Zotero platform, including its interface, features, and capabilities for managing bibliographic information.
[Suggestion/Working hours-Invest time in exploring and understanding the features of Zotero(<https://www.zotero.org/>) through guided tutorials and hands-on experience and gain proficiency in using Zotero to input, organize, and format references, and effectively manage bibliographic data]
3. How to read research paper and develop a thorough understanding of the three-pass approach for effective note-taking from research readings.
4. Review and analyze collected references systematically to identify at least three prospective research problems or gaps in your domain.
[Suggestion/Working hours:-Review a minimum of 20 relevant references in your domain to gain a comprehensive understanding of current research trends and gaps. Dedicate focused time each week to systematically review references and refine your problem identification skill]
5. Write at least three research objectives and three hypotheses that are well-defined, focused, and aligned with the research problem.
[Suggestion/Working hours:-Within one month, be able to formulate clear and relevant research objectives or hypotheses for the given research problem. Seek feedback from mentors or advisors to refine your research objectives or hypotheses and ensure their relevance and clarity.]
6. Create a graph (line/bar/pie) using Microsoft Excel. Prepare publication ready graph and write legend for the graph and table.
7. Understand structure of scientific poster. Write well-structured scientific poster that effectively communicates research findings, adheres to design principles, and captures audience attention.
8. Understand structure of oral presentation and demonstrate the ability to deliver a clear and engaging oral presentation, incorporating effective communication techniques, and supporting visual aids.
9. Find out how to use the chosen plagiarism detection tool step by step to check a paper for possible instances of plagiarism. Attain the ability to use the chosen plagiarism detection

tool proficiently, including uploading documents, interpreting plagiarism reports, and understanding similarity scores.

10. Write one page research proposal. Write research proposal in the format of any funding agency.
11. Write minireview article.
12. Write short communication with one table and one figure.
13. Write scientific blog.