Pre-Ph.D.
Course work Syllabus
(2026-2027) onwards

Sem.	Paper Code	Title of the Paper	No. of Lectures (Hrs.) / Duration	Credits
One	H-049	Research Methodology	60	04
		Advanced Mathematics I	60	04
		Advanced Mathematics II	60	04
		Survey/ Research Project	One semester	04

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Head
Department of Mathematics
Chaudhary Charan Singh University
Meerut-250004

Members from the Board of Studies
(29-5-2026)

S. No.	Name	Designation	College/ University	Signature
1	Prof. HareKrishna	Dean Faculty of Science	Chaudhary Charan Singh University, Meerut.	
2	Prof. Jaimala	Senior Professor	Chaudhary Charan Singh University, Meerut.	29-05-2026
3	Prof. Mukesh Kumar Sharma	Convener I	Chaudhary Charan Singh University, Meerut.	29/5/2026
4	Prof. Anirudh Kumar Bhargava	Convener II	MMH College, Ghaziabad	
5	Prof. Rishi Kumar Agarwal	Member	DBPS College, AnoopShahr (BSR)	
6	Prof. Anurag sharma	Member	DN (PG) College, Meerut	
7.	Prof. Aditya Kaushik	External Subject Expert	Delhi Technological University, Delhi	
8.	Prof. M. K. Sharma	External Subject Expert	Guru Jambheshwar University, Hisar	
9.	Prof. R. C. Dimri	External Subject Expert	HNB Garahwal Central University, Srinagar	online
10.	Prof. Dinesh Khattar	Principal	Kirori Mal College, University of Delhi, Delhi	
11.	Dr. Manoj Kumar	Scientist-E	DRDO Delhi	

Pre-Ph.D. Course Work

Paper I: Research methodology

Program: **Pre-PhD. Course Work**	Subject: Mathematics
Six Months	**Semester: First**
Max. Marks: 100	External Assessment: 100%
Credits: 4	Course Title: **Research Methodology**

Course Objectives: The main objective of this paper is to

1. Identify and discuss the role and importance of research in the social sciences.
2. Identify and discuss the issues and concepts salient to the research process.
3. Identify and discuss the complex issues inherent in selecting a research problem, selecting an appropriate research design, and implementing a research project.
4. Identify and discuss the concepts and procedures of sampling, data collection, analysis and reporting.

Course Outcomes: At the end of this course, the students should be able to:

CO1. Understand some basic concepts of research and its methodologies.
CO2. Explain key research concepts and issues read, comprehend, and explain research articles in their academic discipline.
CO3. Select and define appropriate research problem and parameters.
CO4. Organize and conduct research (advanced project) in a more appropriate manner.
CO5. Write a research report and thesis.
CO6. Write a research proposal (grants).

Unit	Topics	No. of Hours
I	Perception & Definition of Research, Objectives & Motivations of Research, Importance of Research, Types of Research, Research Methods versus Methodology, Process of Research: Review of Literature, Formulation of the Research Problem, Sources and Identification of a Research Problem, Status of the Research Problem, Formulation of Hypothesis, Research Design,	12
II	Outlines of Synopsis; Project Proposal, Project Report Writing; Research Paper Writing; Components of Research Reports; Thesis Writing: Outlines of Thesis, Reference citing, Formats of Writing References, Bibliography; Plagiarism.	12
III	Intellectual Property (IP), Intellectual Property Rights (IPR), Intellectual Property Law, Different fields of Intellectual Property Rights, Patents, Publication Ethics: Definitions importance Conflicts of Interest Publication Misconduct Definition, Concept, Problems that lead to Unethical Behavior and vice versa, Types Identification of publication misconduct, Complaints	12

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	and Appeals; Violation of publication ethics, Authorship and Contributor ship; Predatory Publishers and Journals.	
IV	Web Browsers, Search Engines, MS Word: Handling Graphs, Tables and Charts, Formatting in MS-Word, MS Power Point: Creating Slide Show, Screen Layout and Views, Applying Design Template, MS Excel: Features, Formulas and Functions.	12
V	Subject Classification Index, Citation, Citation Index, Impact Factor, h-index, i-10index, INFLIBNET, Introduction to Peer Reviewed and Open Access Journals, e-Journals, e-Library, Research Databases, Institute for Scientific Information (ISI) & Journal Citation Reports, Science Citation Index (SCI), Social Sciences Citation Index (SSCI), Arts and Humanities Citation Index (AHCI), Databases: UGC care list, Web of Science (WoS), Scopus.	12

Suggested Readings:

1. **Creswell. W.**: Research Design, Qualitative, Quantitative and Mixed Methods Approaches (3rdEdition), SAGE, Inc., 2018.
2. **Gupta. S**: Research Methodology: Methods and Statistical Techniques, Deep & Deep Publications, 2010.
3. **Gupta. S.P.:** Statistical Methods, Sultan Chand &Sons, 2014.
4. **Kumar. R**: Research Methodology: A Step-by-Step Guide for Beginners (3rd Edition), SAGE, Inc., 2011.
5. **Melville. S. and Goddard. W.:** Research Methodology: An Introduction (2nd edition), Juta Academic, 2004.
6. **Shortis, T.**: The Language of ICT: Information and Communication Technology, Taylor & Francis, 2016.
7. Research Methodology: Methods and Techniques – C. R. Kothari and Gaurav Garg, New Age International Publishers, New Delhi, 4th Revised Multicolour Edition, 2019. ISBN: 978-9386649225.
8. Handbook of Writing for the Mathematical Sciences – Nicholas J. Higham, Society for Industrial and Applied Mathematics (SIAM), Philadelphia, 3rd Edition, 2020. ISBN: 978-1611976090.
9. An Introduction to Mathematical Writing – Franco Vivaldi, Springer, London, 2nd Edition, 2014. ISBN: 978-1447165286.

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Paper II: Advance Mathematics I

Program: **Pre-Ph.D. Course Work**	Subject: Mathematics
Six Months	**Semester: First**
Max. Marks: 100	External Assessment: 100%
Credits: 04	Course Title: **Advance mathematics I**

Course Objectives

1. To introduce advanced optimization techniques including nonlinear, quadratic, and integer programming methods for solving complex decision-making problems.
2. To develop understanding of reliability theory and reliability evaluation of engineering systems under different configurations and failure conditions.
3. To provide knowledge of fuzzy set theory, fuzzy inference systems, and fuzzy decision-making techniques for handling uncertainty and imprecision.
4. To study finite fields and Galois theory with emphasis on splitting fields, automorphisms, Galois groups, and solvability of polynomials by radicals.
5. To enhance analytical and computational skills for applications in operations research, reliability engineering, artificial intelligence, and abstract algebra.

Course Outcomes

After successful completion of the course, students will be able to:

1. Formulate and solve nonlinear, quadratic, and integer programming problems using optimization techniques such as Kuhn–Tucker conditions, Wolfe's method, Branch and Bound, and Gomory's cutting plane method.
2. Analyze reliability characteristics of engineering systems and compute reliability measures for series, parallel, standby, and complex system configurations.
3. Apply fuzzy set operations, fuzzy inference mechanisms, and fuzzy optimization techniques to decision-making problems under uncertainty.
4. Explain the structure and properties of finite fields, splitting fields, and automorphisms, and determine Galois groups of polynomials.
5. Investigate solvability of polynomial equations by radicals using concepts from Galois theory and abstract algebra.

Unit	Topics	No. of Hours
I	Nonlinear programming, Kuhn-Tucker optimality condition, Quadratic programming: Wolfe's method. Integer programming: Modeling using pure and mixed integer programming. Branch and Bound technique. Gomory's cutting plane algorithm.	15
II	Basic Concepts of Reliability: General Reliability Function, Failure and Failure modes, Hazard Rate, Bath tub Curve, Mean Time to Failure, Availability concepts. System Reliability: Reliability of Series, Parallel, Stand by Redundancy,k-out-of-n Configuration, Series-Parallel, Parallel-Series configurations and Bridge Structure.	15
III	Constructions of Fuzzy Sets and Operations on Fuzzy Sets, Fuzzy Optimization, Fuzzy control and fuzzy expert systems, Fuzzy Inference: Composition rule, Fuzzy rule and Implication, Inference Mechanism, Inference methods, Fuzzy Sets in Decision-Making: Fuzzy Rank Methods & ordering, Multi criteria Decision Making, decision- making under Fuzziness.	15
IV	Automorphism on a finite field, Structure of multiplicative group of a finite field, Uniqueness of the splitting field, Determining the degree of the splitting field of polynomials over a field, Finding the splitting field of polynomials over a field, Galois group of a polynomial over a field, Determining the elements of the Galois group of	15

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	polynomials over a field, Solvability by radicals, Solvability of Galois group of a polynomial over a field.	

Essential/ Recommended Readings:

Suggested Readings:

1. **Balagurusamy. E:** Reliability Engineering, Tata McGraw Hill Publications, New Delhi, 2010.
2. **Dubosisand. D, Prade. H:** Fuzzy Sets and Systems Theory and Applications, Academic Press, New York, 1980.
3. **Bazara. M. S., Sherali. H.D, Shetty .C.M:** Nonlinear Programming-Theory and Algorithms (3rd Edition), John Wiley& Sons, Inc., Hoboken, New Jersey, 2006.
4. **Cai, Kai-Yuan**: Introduction to Fuzzy Reliability, Kluwer Academic Publishers, Boston/Dordrecht/London,1996.
5. **George J. Klir and BoYuan:** Fuzzy Sets and Fuzzy Logic: Theory and Applications, Prentice Hall of India, New Delhi, 2009.
6. **Lidl. R., Niederreiter. H**: Introduction to Finite Fields and their Applications (2nd Edition), Cambridge University Press, 1994.
7. **Taha. H. A:** Operations Research-An Introduction (10thEdition), Pearson Publication, 2017.

Teaching Learning Process: Class discussions/ demonstrations, Power point presentations, Class activities/ Assignments etc.

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Paper III: Advance Mathematics II

Program: **Pre-Ph.D. Course Work**	Subject: Mathematics
Six Months	**Semester: First**
Max. Marks: 100	External Assessment: 100%
Credits: 04	Course Title: **Advance Mathematics II**

Course Objectives:

The objective of this course is

1. To develop an understanding of advanced inventory models, demand patterns, deterioration, shortages, and warehouse management techniques in operations research.
2. To study the fundamentals of hydrodynamic and thermal stability theory and analyze different fluid instability phenomena under varying physical conditions.
3. To introduce modern cryptographic systems including public key cryptography, discrete logarithm problems, and elliptic curve cryptography for secure communication.
4. To provide a rigorous foundation in inner product spaces and Hilbert spaces with emphasis on orthogonality, projections, duality, and convergence concepts in functional analysis.
5. To enhance analytical, mathematical, and problem-solving skills for applications in engineering, applied mathematics, and computational sciences.

Course Outcomes:

After successful completion of the course, students will be able to:

1. Analyze and formulate deterministic inventory models considering deterioration, shortages, lead time, imperfect production, preservation technology, and multi-warehouse systems.
2. Apply stability theory and normal mode techniques to investigate fluid flow instabilities, thermal convection, and effects of magnetic fields, rotation, and surface tension.
3. Explain and implement cryptographic algorithms based on discrete logarithm and elliptic curve concepts, including Diffie–Hellman and ElGamal cryptosystems.
4. Demonstrate understanding of Hilbert spaces, orthogonality, projections, dual spaces, and important theorems such as Riesz representation theorem.
5. Solve advanced mathematical problems involving convergence, bounded linear functionals, and orthonormalization techniques with theoretical rigor and practical relevance.

Unit	Topics	No. of Hours
I	Analytical structure of inventory problems, Different types of demand pattern. Concept of deterioration and shortages. Concept of lead time, Deterministic inventory models, Trapezoidal type demand rate, Stock and price dependent consumption rate, deterioration, time-varying deterioration, imperfect production process, preservation technology, Two-warehouse inventory model, different type of holding costs. Concept of partial backlogging and lost sales.	15
II	Basic concepts of Stability Theory, Normal Mode Technique, Stability of flow between two parallel plates: Instability of an inviscid fluid layer, Instability of plane Poiseuille flow. Thermal instability of layer of fluid heated from below: the Benard convection, the Bossiness' approximation, the principle of exchange of stabilities. Stability of superposed fluids: the Rayleigh Taylor instability, stability of non-viscous and viscous (with constant viscosity) stratified fluids, effect of surface tension, effect of rotation,	15

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	effect of horizontal and vertical magnetic field.	
III	Secret key cryptography and Public key cryptography, The discrete logarithm problem, Discrete logarithm problem over a finite field. Diffie-Hellman Key Exchange. Elliptic curves, Elliptic curves over finite field, The elliptic curve discrete logarithm problem. Elliptic curve cryptography: Elliptic curve Diffie-Hellman Key Exchange, Elliptic curve Elgamal cryptosystem.	15
IV	Inner product spaces, Hilbert spaces and their examples, Apolloniu's identity, Schwarz inequality, Triangle inequality, Orthogonality, Pythagorean theorem, Gram-Schmidt orthonormalization process, Continuity of inner product, Completion of an inner product space, Subspace of a Hilbert space, Orthogonal complements and direct sums, Projection, Projection theorem, Dual basis and dual spaces, Riesz representation theorem for bounded linear functionals on a Hilbert space, Strong and weak convergence.	15

Suggested Readings:

1. **Chandrasekhar. S.:** Hydrodynamic and Hydromagnetic Stability, Dover Publications, New York, 1981.
2. **G., Whitin. T.M.:** Analysis of Inventory-Systems, Prentice Hall Inc.,1963.
3. **Hoffstein. J, Pipher. J, J.H. Silverman:** An Introduction to Mathematical Cryptography (2nd Edition), Springer, 2014.
4. **Kreyszig. E.:** Introductory Functional Analysis with Applications, John Wiley and Sons, New York, 1978.
5. **Meijer. A. R.**: Algebra for Cryptologists (1st Edition), Springer, 2016.

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