Programme Outcomes, Programme Specific Outcomes and Course Outcomes

for

Ph.D. Programs

Program Name: Ph.D. in Mathematics

Department of Mathematics
University of North Bengal
West Bengal, INDIA

Program Outcomes

- Developing skills to critically examine the background literature relevant to their specific research area.
- To prepare students for a career in research and teaching at college and university level.
- To prepare students for professions other than teaching, that requires independent mathematical research, advanced mathematical knowledge, critical analysis and thoughtful synthesis.
- The opportunity to expand the student's knowledge of their research area, including its theoretical foundations and the specific techniques used to study it.

Program Specific Outcomes

- Thorough knowledge of the literature and a comprehensive understanding of scientific methods and techniques applicable to their own research.
- Be able to act autonomously in the planning and implementation of research.
- Be able to communicate complex ideas effectively both verbally and in writing, which includes the ability to write their Ph.D. thesis, give presentation at various conferences and to submit a research paper or article to a journal for publication.

Paper Code	Unit Title	Marks	Credits
PCWMATH 1	Research Methodology Unit -1: Research Foundation	50	2
	Research Methodology Unit -2: Mathematical Typesetting as a Computer Applications in Research	50	2
PCWMATH 2	T: Theory of Convergence and Topological Hyperalgebra	50	2
	C: Theory of Entire and Meromorphic Functions	50	2
	M: Measure Theory	50	2
	A: Algebra	50	2
	N: Number Theory	50	2

Ph.D. Course Work
(Mathematics)

Paper Code	Unit Title	Course Outcomes
PCWMATH 1	Research Methodology Unit -1: Research Foundation	Knowledge gained: • Basic introduction of methodology used in research in general and mathematical science in particular. • Identification of research problems and sub-problems. • Different technique of interpretation. • Ethical issues and professional conduct. • Literature review Skills gained: • Ability to learn criteria of good research. • Defining techniques involved in different problems. • Understanding characteristics of research documentations (reviews, treatise, monographs, technical report, white paper, thesis, research paper.) • Techniques of writing project proposals, paper presentation, and soft skills. Competency developed: • Professional ethics, ethical issues and their significance those arises from computer technology. • Concept of ethical issues related to plagiarism and intellectual property rights. • Importance of different issues in defining a research problem including literature in research proposal, critique, survey and pre-review process. • Identifying gaps areas from literature review.
PCWMATH 1	Research Methodology Unit -2: Mathematical Typesetting as a Computer Applications inResearch	Knowledge gained: • Use of various document classes for example: article.cls, book.cls • Use of different packages like amssymb,amsmath,amsfonts,graphics. • Paper /article writing by using Latex which are compatible with almost all mathematical journals (MatSciNet, Scopus, Taylor Francis, Springer etc.) • Preparing presentation using beamer Skill gained: • Ability for framing preamble according to desired looks of presentation. Competency developed: • Ability for further use of new softwares towards making good documents.
PCWMATH 2 (T)	Theory of Convergence and Topological Hyperalgebra	Knowledge gained: • Definition of natural density. • Concept of statistical convergence • Basic properties of statistical convergence. • Concept of I and I^*-convergence. • Concept of I-λ statistical convergence. • Concept of topological groups, semigroups and rings. • Definition of topological hyperstructures. • Topological polygroups. Skills gained: • Comparing the differences between classical convergence and statistical convergence. • Comparing the differences between statistical convergence and I-convergence. • Analyzing the structure of the set of all I-convergent sequence. • Comparing the differences between I and I^*-convergence. • Comparing the differences between topological groups and topological rings.

		Competency developed: • Comparing the differences between basis and Schauder basis. • Ability of applying the concepts of statistical convergence, I and I^*-convergence. • Applications of topology towards extension of the study of topological algebraic hyperstructures. • Computing the isomorphism theorem.
PCWMATH 2 (C)	Theory of Entire and Meromorphic Functions	Knowledge gained: • Meromorphic functions, Properties of Nevanlinna's characteristic function. • Growth of meromorphic functions, Comparative growth of functions. • Deficiencies of meromorphic functions. Skills gained: • Nevanlinna characteristic function is like maximum modulus function for meromorphic functions. • Order of growth of functions. • Relation between maximum modulus function and Nevanlinna characteristic function. Competency developed: • Explore properties of meromorphic functions with Nevanlinna characteristic function. • Factorization of function in terms of zeros and poles. • Calculation of counting function and proximity function.
PCWMATH 2 (M)	Measure Theory	Knowledge gained: • Lebesgue outer measure and Lebesgue measure on Euclidean space. • Borel measure space of n-dimension and its completion • s-dimensional Hausdorff measure on R^n for $s \in [0, \infty)$ and Hausdorff dimension of a subset of R^n. Skills gained: • Ability of constructing Lebesgue outer measure and Lebesgue measure on Euclidean space using covering classes • Estimating Lebesgue measure on $\mathbb{R}^n$ by closed a compact sets and approximation by open sets. • Determination of Hausdorff dimension of a set $E \subset \mathbb{R}^n$. Competency developed: • Realizing importance of Borel measurability and metric outer measurability in the related theory. • Understanding the role of completion to obtain Lebesgue measure space via Borel measure space in $\mathbb{R}^n$. • Building a foundation for study Cantor sets, Fractals, etc.
PCWMATH 2 (A)	Algebra	Knowledge gained: • Concept of Normal series, Subnormal series, solvable series. • Solvable groups, Nilpotent groups, Torsion group, finitely generated Abelian groups etc. • Noetherian Rings, Artinian Rings etc. • Galois groups, Cyclotomic field extension, Radical extensions, Algebraic independence etc. Skill gained: • Construction of different groups, e.g. solvable groups, nilpotent groups etc. • Solving problems using fundamental theorem of Abelian groups. • Ability to build different Galois groups and Galois fields. Competency developed: • Ability to study these concepts in different algebraic structures, theories. • Interest as well as capability to studyCoding Theory, Cryptography

		etc.
PCWMATH 2 (N)	Number Theory	Knowledge gained: • Dirichlet series, multiplication of Dirichlet series. • Riemann zeta function, its functional equation and analytic continuation, its relation with distribution of primes. • Analytic proof of prime number theorem Skill gained: • Finding zero free regions of Riemann zeta function • Ability to understand distribution of primes • Ability to deal with different Dirichlet series. Competency developed: • Useful tools to deal with various problems in analytic number theory.