SCHOOL OF VOCATIONAL STUDIES & APPLIED SCIENCES

Programme and Course Objectives

DEPARTMENT OF APPLIED MATHEMATICS

Department of Applied Mathematics

NUMBER OF PROGRAMMES OFFERED : 03
Ph.D in Applied Mathematics
M. Sc. Applied Mathematics
B.Sc [Hons.] Mathematics

Programme Objectives ofPh.D. Applied Mathematics

Applied mathematics addresses problems in science, engineering, and society. Find new ways to solve real-world problems through original, creative research in applied mathematics Ph.D. program. Our student learning outcomes are focused around knowledge areas, skills and attitudes. Each of the objectives for the Applied Mathematics PhD program are detailed below.

1. Students should gain operational understanding of Analysis.

2. Students should gain operational understanding of Linear Algebra.

3. Students will be able to orally present their mathematics, or the mathematics of others, with the aid of relevant presentation software (PowerPoint, LaTeX) as appropriate.

4. Students will be able to present mathematics in writing, utilizing the appropriate conventions of the discipline. This may involve summary and analysis of the mathematics of others, development (including proof) of their own mathematics, or both.

5. Students will acquire depth of knowledge in one of the following mathematical disciplines

   a. Algebra, Cryptography

   b. Numerical Weather Prediction

   c. Operations Research

   d. Differential Equations

6. Doctoral students will be able to produce original, publishable mathematics research.

7. Doctoral students engaged in teaching assistantships will become effective classroom educators.

Programme Objectives ofB.Sc. (Hons.) Mathematics (BHM)

- To develop a positive attitude towards mathematics as an interesting and valuable subject of study.
- To analyze a problem, identify and define the computing requirements, which may be appropriate to its solution.
- To develop the Writing, Listening and Teaching Skills and promoting their thinking ability.
- To introduce the various courses like group theory, ring theory, number theory, metric spaces, programming in Latex and HTML, Analysis, Partial Differential Equations, Discrete Mathematics etc.
- To enhancing student's overall development and to equip them with mathematical modeling abilities, problem solving skills, creative talent and power of communication necessary for various kinds of employment.
- To formulate and develop mathematical arguments in a logical manner.
- Acquire good knowledge and understanding in advanced areas of mathematics chosen by the student from the given courses.

Semester	S. No.	Course Code	Course Name	Objectives
First	1	MT101/ MT105	Calculus/ Calculus Lab	Upon successful completion of Calculus the student will be able to: • Analyze functions using limits, derivatives, and integrals. • Recognize the appropriate tools of calculus to solve applied problems.
	2	MT103	Algebra	**Algebra** involves the representation and manipulation of mathematical information using variables. • Evaluate Inverse of matrix using elementary operation and application of Matrices to solve systems of linear equations . • Understand Theory of Equations. • Understand group theory, ring theory, field, Integral Domain.
	3	ES101	Environmental Studies	Understand core concepts and methods from ecological and physical sciences and their application in environmental problem-solving. Appreciate key concepts from economic, political, and social analysis as they pertain to the design and evaluation of environmental policies and institutions.
	4	GE-1	Generic Elective/Interdisciplinary	
Se	1	MT102	Real Analysis	Upon successful completion of this course the student will be able to:

				• Demonstrate an understanding of limits and how they are used in sequences, series, differentiation and integration. • Appreciate how abstract ideas and rigorous methods in mathematical analysis can be applied to important practical problems.
	2	MT104/ MT 106	Differential Equations/ Differential Equations Lab	After studying this course, students should be able to: • recognise differential equations that can be solved by each of the three methods – direct integration, separation of variables and integrating factor method – and use the appropriate method to solve them • understand the terms 'exponential growth/decay', 'proportionate growth rate' and 'doubling/halving time' when applied to population models, and solve the problems involving exponential growth and decay.
	3	EN105	Communicative English	At the completion of the course the students will be able to: • develop vocabulary and improve the accuracy in grammar. • produce words with right pronunciation. • Improve LSRW- listening, speaking, reading and writing skills and the related sub-skills. • demonstrate positive group communication exchanges.
	4	GE-2	Generic Elective/Interdisciplinary	
Third	1	MT201	Theory of Real Functions	This course will enable the students to: • Have a rigorous understanding of the concept of limit of a function. • Learn about continuity and uniform continuity of functions defined on intervals. Understand geometrical properties of continuous functions on closed and bounded intervals. • Learn extensively about the concept of differentiability using limits, leading to a better understanding for applications. • Know about applications of mean

				value theorems and Taylor's theorem.
	2	MT203	Group Theory-I	On completion of this unit successful students will be able to: • Demonstrate when a binary algebraic structure forms a group. • Construct Caley tables. • Determine possible subgroups of a group. • Identify normal subgroups of a group.
	3	MT205/ MT 209	Multivariate Calculus/ Multivariate Calculus Lab	On completion of this unit successful students will be able : • How to deals with vector valued functions • To understand topics like line integral ,surface integral which generalize integration to functions defined on curves & surfaces. • To understanding the computation of work done ,flux,mass,area of the surfaces. • To understand the Greens theorem , Stokes theorem ,divergence theorem that teaches the relation between integration of functions over surfaces & its boundry,solids& its surface
	4	MT207	Latex and HTML	After studying this course the student will be able to: • Create and typeset a LaTeX document. • Typeset a mathematical document using LaTex. • Learn about pictures and graphics in LaTex. • Create beamer presentations. • Create web page using HTML
	5	GE-3	Generic Elective/Interdisciplinary	
Fourth	1	MT202/ MT 210	Partial Differential Equations/ PDE Lab	• Explain the concepts and language of partial differential equations. • Classify the partial differential equations • Solve the partial differential equation using charpits method, Jacobis method
	2	MT204	Riemann Integration and Series of Functions	The course will enable the students to: • Learn about some of the classes and properties of Riemann integrable functions,

				and the applications of the Fundamental theorems of integration. • Know about improper integrals including, beta and gamma functions. • Learn about Cauchy criterion for uniform convergence and Weierstrass M-test for uniform convergence. • Know about the constraints for the inter-changeability of differentiability and integrability with infinite sum. • Approximate transcendental functions in terms of power series as well as, differentiation and integration of power series.
	3	MT206	Ring Theory and Linear Algebra-I	On successful completion of this course unit students will be able to • Understand the basic ideas of vector algebra: linear dependence and independence and spanning; • Know how to find the row space, column space and null space of a matrix, and be familiar with the concepts of dimension of a subspace and the rank and nullity of a matrix, and to understand the relationship • of these concepts to associated systems of linear equations; • Be familiar with the notion of a linear transformation and its matrix; • Find the Gram-Schmidt orthogonalization of a matrix
	4	MT208	Computer Algebra Systems and Related Software	This course will enable the students to: • Use of computer algebra systems (Mathematica/MATLAB/Maxima/ Maple etc.) as a calculator, for plotting functions and animations • Use of CAS for various applications of matrices such as solving system of equations and finding eigenvalues and eigenvectors. Understand the use of the statistical software R as calculator and learn to read and get data into R. • Learn the use of R in summary calculation, pictorial

				representation of data and exploring relationship between data. • Analyze, test, and interpret technical arguments on the basis of geometry.
	5	GE-4	Generic Elective/Interdisciplinary	
Fifth	1	MT301	Metric Spaces	On completion of this unit successful students will be able to: • Deal with various examples of metric spaces; • Have some familiarity with continuous maps; • Work with compact sets in Euclidean space; • Work with completeness; • Apply the ideas of metric spaces to other areas of mathematics.
	2	MT303	Group Theory-II	On completion of this unit successful students will be able to: • Examine symmetric and permutation groups. • Explain group and subgroup orders using Lagrange's theorem. • Identify cyclic subgroups and their generators.
	3	DSE-1	DSE (including practical)	The course will enable the students to: • Learn some numerical methods to find the zeroes of nonlinear functions of a single variable and solution of a system of linear equations, up to a certain given level of precision. • Know about methods to solve system of linear equations, such as Gauss−Jacobi, Gauss−Seidel and SOR methods. • Interpolation techniques to compute the values for a tabulated function at points not in the table. • Applications of numerical differentiation and integration to convert differential equations into difference equations for numerical solutions.
	4	DSE-2	DSE	
Sixth	1	MT302/ MT 306	Complex Analysis/ Complex Analysis Lab	Upon successful completion Complex Analysis, a student will be able to: • Represent complex numbers algebraically and geometrically,

				• Define and analyze limits and continuity for complex functions as well as • consequences of continuity, • Apply the concept and consequences of analyticity and the CauchyRiemann equations and of results on harmonic and entire functions including the fundamental theorem of algebra, • Analyze sequences and series of analytic functions and types of convergence, • Evaluate complex contour integrals directly and by the fundamental theorem, apply the Cauchy integral theorem in its various versions, and the Cauchy integral formula, and • Represent functions as Taylor, power and Laurent series, classify singularities and poles, find residues and evaluate complex integrals using the residue theorem.
	2	MT304	Ring Theory and Linear Algebra-II	Upon successful completion of this course, students will be able • To write precise and accurate mathematical objects in ring theory • For checking the irreducibility of higher degree polynomials over rings. • To understand the concepts like ideals and quotient rings. • To understand the concept of ring homomorphism.
	3	DSE-3	DSE	This course will enable the students to: 1. Learn about probability density and moment generating functions. 2. Know about various univariate distributions such as Bernoulli, Binomial, Poisson, gamma and exponential distributions. 3. Learn about distributions to study the joint behavior of two random variables. 4. Measure the scale of association between two variables, and to establish a formulation helping to predict one variable in terms of the other, i.e., correlation and linear regression. 5. Understand central limit theorem, which helps to

					understand the remarkable fact that: the empirical frequencies of so many natural populations, exhibit a bell-shaped curve, i.e., a normal distribution.
	4	DSE-4	DSE		

M.Sc. Applied Mathematics

Program Objectives:

1. Enabling students to develop a positive attitude towards mathematics as an interestingand valuable subject of study.
2. Enabling students to analyze a problem, identify and define the computing requirements, which maybe appropriate to its solution.
3. Introduction to various courses of pure and applied mathematics like Abstract Algebra, Real Analysis, Linear Algebra, Number theory, Complex Analysis, Topology, Differential Geometry, Measure and Integration, Functional Analysis, Ordinary Differential Equations, Partial Differential Equations, Integral Equations and Calculus of Variations at PG level.
4. Enhancing student's overall development and to equip them with mathematical modelingabilities, problem solving skills, creative talent and power of communication necessaryfor various kinds of employment.
5. Encourage students to pursue advanced studies and research in pure and applied mathematicalsciences.

Course Objectives:

Semester	S. No.	Course Code	Course Name	Objectives
First	1	MA401	**Linear Algebra**	On completion of this course students will be expected to: 1. To understand the concept of Linear transformation, Linear operators, algebra of Linear transformations and Linear operators. 2. To understand the concept of Diagonalization and its applications. 3. To understand the concept of Jordan canonical forms, Rational canonical forms. 4. To understand the concept of Quadratic forms and its applications in Geometry and number theory. 5. To understand the concept of Inner product space and its application.
		MA403	**Abstract Algebra:**	**On completion of this course students will be expected to:** 1. To understand the concept of Sylow theorem and its apllications. 2. To understand the concept of groups and its applications. 3. To understand the concepts of rings and its

				associated structures. 4. To understand the concepts of integral domains, fields, field extension and their applications. 5. To understand the concepts of Galois group and its applications in solvability.
		MA405	**Real Analysis:**	**On completion of this course students will be expected to:** 1. To understand the construction of natural numbers, integers, rational numbers and real numbers. Explain the completeness of a system of real numbers: a least upper bound, a greatest lower bound. 2. Elaborate on the topological concepts of the real numbers: open sets, closed sets, accumulation points, closure, open covers, connected sets, compact sets. Deal with various examples of metric spaces. Apply the ideas of metric spaces to other areas of mathematics 3. To Understand the concept of Riemann Integrability and various fundamental results. 4. To Understand the concept of sequence and series of functions: point-wise and uniform convergence, Weierstrass approximation theorem. 5. To Understand the concept of power series, Fourier series 6. To Understand the concept of differentiability in R^n. 7. To Understand the implicit function theorem, inverse function theorem, contraction mapping theorem, rank theorem. 8. To Understand the concept of differentiation of integrals and integration of differential forms.
		MA407	**Ordinary Differential Equations:**	**On completion of this course students will be expected to:** 1. Explain the concept of differential equation, classify the differential equations with respect to their order and linearity and explain the meaning of solution of a differential equation. 2. Able to understand the Variation of parameter method, Wronskian, fundamental solutions, Qualitative properties of the solutions of second order ODE. 3. Able to understand Initial Value Problems, Existence and uniqueness of solutions to first order equations: Picard's Theorem, Lipschitz condition. 4. Able to understand Power Series Method, Regular Singular Points, Frobenius Method. 5. Able to understand boundary value problems and their solution techniques.
		MA409	**Number Theory and**	**On completion of this course students will be expected to:**

			Cryptography:	1. Able to understand the Notion of Complexity Theory, Euclidean algorithm, The fundamental theorem of arithmetic. 2. Able to understand Factorization methods, Linear Diophantine equations. Congruences linear congruences, Chinese remainder theorem. 3. Able to understand Wilson's, Fermat's, and Euler's theorem, Euler's Phi-function and its Applications to Congruences. 4. Able to understand Classical Cryptosystems, Crypt analysis, Perfect Secrecy, Stream Ciphers, Block Ciphers, Hash Functions. 5. Able to understand Public-key cryptography: RSA, Implementation of RSA, Primality Testing, Factoring Algorithm.
		MA404	**Topology:**	**On completion of this course students will be expected to:** 1. To understand the concepts of basic set theory. 2. Understand terms, definitions and theorems related to topology. 3. Demonstrate knowledge and understanding of concepts such as open and closed sets,interior, closure and boundary. 4. Create new topological spaces by using subspace, product and quotient topologies. 5. Use continuous functions and homeomorphisms to understand structure of topological spaces. 6. To be able to understand the purpose of separation axioms.
		MA406	**Operations Research:**	**On completion of this course students will be expected to:** 1. Apply the techniques used in operations research to solve real life problem in mining,industry and various fields. 2. Turn real life problems into formulation of models to be solve by linear programming etc. 3. Have complete understanding of duality and its applications. 4. To understand job-sequencingproblems and their applications. 5. To understand game theory problems and their applications. 6. To solve project management problems using PERT and CPM. 7. To understand Goal and dynamic programming and their applications.
		MA408	**Partial Differential Equations:**	**On completion of this course students will be expected to:** 1. Explain the concepts of partial differential equations. 2. Understand the difference between ordinary & partial differential equations.

				3. Classify the partial differential equations. 4. To understand the concept of canonical forms, initial value problems (Cauchy's problem) and boundary value problems. 5. To be able to solve heat, wave and Laplace partial differential equations using separation of variable method. 6. To be able to understand the energy principle and its applications.
		MA410	**Complex Analysis:**	**On completion of this course students will be expected to:** 1. Represent complex numbers algebraically and geometrically, 2. Define and analyze limits and continuity for complex functions as well as consequences of continuity. 3. Apply the concept and consequences of analyticity and the Cauchy-Riemann equations and of results on harmonic and entire functions including the fundamental theorem of algebra. 4. Analyze sequences and series of analytic functions and types of convergence. 5. Evaluate complex contour integrals directly and by the fundamental theorem, apply theCauchy integral theorem in its various versions, and the Cauchy integral formula. 6. Represent functions as Taylor and Laurent series, classify singularities and poles,find residues and evaluate complex integrals using the residue theorem. 7. Analyze the Bilinear transformation, conformal mapping with their applications.
		MA412	**Measure and Integration:**	**On completion of this course students will be expected to:** 1. Able to understand the concepts of Outer Measures, Caratheodory Extension, Lebesgue Measure, Lebesgue Outer Measure, Lebesgue Measurable Sets. 2. Able to understand the concepts of Measurable Functions; Integral of a Simple measurable Function; Integral of Positive Measurable Functions. 3. Able to understand Lebesgue's Monotone Convergence Theorem, Dominated Convergence Theorem. 4. Able to understand the structure of L^p –Spaces and its applications. 5. Able to understand Differentiation and Fundamental theorem for Lebesgue integration, Measure on Product Spaces.

		MA501	**Functional Analysis:**	**On completion of this course students will be expected to:** **1.** Understand the concept of Normed spaces, Banach spaces and Hilbert spaces. **2.** Understand the theory behind bounded linear operators. **3.** Understand the theorems such as: Banach contraction mapping theorem, open mapping and closed graph theorem, Hahn Banach separation/extension theorems, Riesz representation theorem. **4.** Have a clear understanding of spectral theory for various operators. **5.** Understand the concept of Inner product space, duality, weak convergence.
		MA503	**Integral Equations and Calculus of Variation:**	**On completion of this course students will be expected to:** 1. Formulate and classify integral equations. 2. Convert IVP(ODE) to Volterra equations. 3. Convert BVP(ODE) to Fredholm equations. 4. Understand existence and uniqueness of solutions of Integral equations. 5. Understand functionals, Euler's Lagrange equation and conditions for extremals.
		MA502	**Mathematical Statistics with R:**	**On completion of this course students will be expected to** 1. Know the key concept of probability theory. 2. Know the special parametric families of univariate distributions, joint, marginal and conditional distributions. 3. Have a knowledge of covariance and correlation coefficient, joint moment generating function and moments. 4. Know the distributions of functions of random variable: the expectation technique, cumulative distribution technique, transformation technique. 5. Know the sampling and sampling distributions, central limit theorem, standard errors. 6. Understand parametric point estimation, test of hypotheses.
		MA504	**Evolutionary Algorithms:**	**On completion of this course students will be expected to** 1. Understand historical development of genetic algorithms, encoding, fitness function . 2. Know crossover and mutation operators with methodologies of applying these. 3. Know binary GA, Real coded GA, PSO models. 4. Know memetic algorithms, differential evolution, artificial bee colony. 5. Know the multi-objective optimization, use of evolutionary computations to solve multi objective optimization.

		MA506	**Numerical solution of ODE, PDE with MATLAB:**	**On completion of this course students will be expected to** 1. Know various numerical methods for solving IVP, conduct the convergence analysis for explicit one step method. 2. Derive classical Runge-Kutta method and understand Runge-Kutta method of order greater than 4, implicit Runge-Kutta method, multi-step methods, predictor-corrector method, Adam Bashforth method, Milne's method. 3. Have a knowledge of convergence, order and error constant, local and global truncation error, consistency. 4. Have a knowledge of finite difference method for linear equations, Crank Nicholson method, Gerschgorins Theorem, Lax equivalence theorems, linear elliptic equations. Understand the theoretical concepts of stability, consistency and order of accuracy.
		MA508	**Information Theory and Coding Theory:**	**On completion of this course students will be expected to** 1. Understand entropy, differential entropy, Shannon's first theorem. 2. Understand data compression. 3. Have a knowledge of Huffman coding, Universal source coding, Block coding, Convolution coding. 4. Have a knowledge of various codes such as block codes, convolution codes, error correcting codes, linear codes and optimal codes.