**MSc MATHEMATICS**

**PROGRAMME OUTCOMES**

Upon completing the M. Sc degree in the field of Mathematics, students have/capable of:

- A solid understanding of graduate level algebra, analysis and topology.
- Using their mathematical knowledge to analyze certain problems in day to day life .
- Identifying unsolved yet relevant problems in a specific field.
- Undertaking original research on a particular topic.
- Communicate mathematics accurately and effectively in both written and oral form.
- Conducting scholarly or professional activities in an ethical manner.

# COURSE OUTCOMES

## MTH1C01: ALGEBRA – I

Course Outcomes: Upon the successful completion of the course students will:

• Learn factor group computation.

• Understand the notion of group action on a set.

• Understand the notion of free groups.

• Understand the concepts rings of polynomials and ideals.

• Learn basic properties of field extensions

## MTH1C02: LINEAR ALGEBRA

Course Outcomes: Upon the successful completion of the course students will:

• Learn basic properties of vector spaces

• Understand the relation between linear transformations and matrices

• Understand the concept of diagonalizable and triangulable operators and various fundamental results of these operators

• Understand Primary decomposition Theorem.

• Learn basic properties inner product spaces

## MTH1C03: REAL ANALYSIS I

Course Outcomes: Upon the successful completion of the course students will:

• Learn the topology of the real line

• Understand the notions of Continuity, Differentiation and Integration of real functions.

• Learn Uniform convergence of sequence of functions, equicontinuity of family of functions, and Weierstrass theorems.

## MTH1C04: DISCRETE MATHEMATICS

Course Outcomes: Upon the successful completion of the course students will:

• Understand the fundamentals of Graphs

• Learn the structure of graphs and familarize the basic concepts used to analyse different problems in different branches such as chemistry, computer science etc.

• Acquire a basic knowledge of formal languages, grammars and automata.

• Learn the equivalence of deterministic and non deterministic finite accepters.

• Learn the concepts of partial order relation and total order relation.

• Acquire knowledge of Boolean algebras and Boolean function and understand how these concepts arise in certain real life problems.

## MTH1CO5: NUMBER THEORY

Course Outcomes: Upon the successful completion of the course students will:

• Be able to effectively express the concepts and results of number theory.

• Learn basic theory of arithmetical functions and Dirichlet multiplication, averages of some arithmetical functions.

• Understand distribution of prime numbers and prime number theorem.

• Learn the concept of quadratic residue and Quadratic reciprocity laws.

• Get a basic knowledge in Cryptography

## MTH2C06: ALGEBRA II

Course Outcomes: Upon the successful completion of the course students will:

• Be able to apply Sylow's theorem effectively in various contexts.

• Learn automorphisms of fields.

• Get a basic knowledge in Galois Theory.

• Learn how to apply Galois Theory in various contexts.

## MTH2CO7: REAL ANALYSIS II

Course Outcomes: Upon the successful completion of the course students will:

• Learn why and for what the theory of measure was introduced

• Learn the concept of measures and measurable functions

• Learn Lebesgue integration and its various properties

• Learn how to generalize the concept of measure theory.

• Learn that a measure may take negative values.

## MTH2C08: TOPOLOGY

Course Outcomes: Upon the successful completion of the course students will:

• Be proficient in abstract notion of a toplogical space, where continuous function are defined in terms of open sets not in the traditional ε − δ definition used in analysis).

• Realize Intermediate value theorem is a statement about connectedness, Bolzano weierstrass theorem is a theorem about compactness and so on.

• Learn the concept of quotient topology.

• Learn five properties such as T0, T1, T2, T3 and T4 of a topological space X which express how rich the open sets is. More precisely, each of them tells us how tightly a closed subset can be wrapped in an open set.

## MTH2C09: ODE AND CALCULUS OF VARIATIONS

Course Outcomes: Upon the successful completion of the course students will:

• Learn the existence of uniqueness of solutions for a system of first order ODEs.

• Learn many solution techniques such as separation of variables, variation of parameter power series method, Frobeniious method etc.

• Learn method of solving system of first order differential calculus equations.

• Get an idea of how to analyze the behavior of solutions such as stability, asymptotic stability etc.

• Get a basic knowledge of Calculus of variation.

## MTH2C10: OPERATIONS RESEARCH

Course Outcomes: Upon the successful completion of the course students will:

• Learn graphical method and the simplex algorithm for solving a linear programming problem.

• Learn more optimization techniques for solving the linear programming modelstransportation problem and integer programming problem.

• Learn optimization techniques for solving some network related problems.

• Learn sensitivity analysis and parametric programming, which describes how various changes in the problem affect its solution.

## MTH2A02: TECHNICAL WRITING WITH LaTEX (PCC )

Course Outcomes: Upon the successful completion of the course students will learn

1. Installation of the software LATEX

2. Understanding LATEX compilation

3. Basic Syntex, Writing equations, Matrix, Tables

4. Page Layout : Titles, Abstract, Chapters, Sections, Equation references, citation.

5. List making environments

6. Table of contents, Generating new commands

7. Figure handling, numbering, List of figures, List of tables, Generating bibliography and index 8. Beamer presentation

9. Pstricks: drawing simple pictures, Function plotting, drawing pictures with nodes

10. Tikz:drawing simple pictures, Function plotting, drawing pictures with nodes

## MTH2A03: PROGRAMMING WITH SCILAB (PCC)

Course Outcomes: Upon the successful completion of the course students will Learn

1. Installation of the software Scilab.

2. Basic syntax, Mathematical Operators, Predefined constants, Built in functions.

3. Complex numbers, Polynomials, Vectors, Matrix. Handling these data structures using built infunctions

4. Programming

5. Installation of additional packages

6. Graphics handling ,Some Applications different fields in mathematics.

## MTH2A04: SCIENTIFIC PROGRAMMING WITH PYTHON(PCC)

Course Outcomes: Upon the successful completion of the course students will Learn

1. Basic symbols, Operators, and Functions

2. Writing a python script

3. To find roots of Some Nonlinear Equations

4.To find the Direct and iterative Solution of Linear Equations

5. Numerical Differentiation and Integration

6. Numerical Solution of Ordinary Differential Equations

## MTH3C11: MULTIVARIABLE CALCULUS AND GEOMETRY

Course Outcomes: Upon the successful completion of the course students will:

• Be proficient in differentiation of functions of several variables.

• Understand curves in plane and in space.

• Get a deep knowledge of Curvature, torsion, Serret-Frenet formulae

• Learn Fundamental theorem of curves in plane and space.

• Learn the concept of Surfaces in three dimension, smooth surfaces, surfaces of revolution

• Learn explicitly tangent and normal to the surfaces.

• Get a thorough understanding of oriented surfaces, first and second fundamental forms surfaces, gaussian curvature and geodesic curvature and so on.

## MTH3C12: COMPLEX ANALYSIS

Course Outcomes: Upon the successful completion of the course students will:

• Learn the concept of (complex) differentiation and integration of functions defined on the complex plane and their properties.

• Be thorough in power series representation of analytic functions, different versions of Cauchy's Theorem.

• Get an idea of singularities of analytic functions and their classifications.

• Learn different versions of maximum modulus theorem.

## MTH3C13: FUNCTIONAL ANALYSIS

Course Outcomes: Upon the successful completion of the course students will:

• Learn the concept of normed linear spaces and various properties operators defined on them.

# MTH3C14: PDE AND INTEGRAL EQUATIONS

Course Outcomes: Upon the successful completion of the course students will:

• Learn a technique to solve first order PDE and analyse the solution to get information about the parameters involved in the model.

• Learn explicit representations of solutions of three important classes of PDE Heat equations Laplace equation and wave equation for initial value problems.

• Get an idea about Integral equations

• Learn the relation between Integral and differential Equations

## MTH3E02: CRYPTOGRAPHY

Course Outcomes: Upon the successful completion of the course students will learn to

• Understand the fundamentals of cryptography and cryptanalysis.

• Acquire a knowledge of Claude Shanon's ideas to cryptography, including the concepts of perfect secrecy and the use of information theory to cryptography.

• Learn to use substitution -permutation networks as a mathematical model to introduce many of the concepts of modern block cipher design and analysis including differential and linear cryptoanalysis.

• Familiarize different cryptographic hash functions and their application to the construction of message authentication codes.

## MTH3E03: MEASURE AND INTEGRATION

Course Outcomes: Upon the successful completion of the course students will:

• Learn how a measure will be helpful to generalize the concept of an integral.

• Learn how a smallest sigma algebra containing all open sets be constructed on a topological space which ensures the measurability of all continuous function and how a measure called Borel measure is defined on this sigma algebra which ensures the integrability of a huge class of continuous functions.

• Understand the regularity properties Borel measures.

• Realize a measure may take real values even complex values.

• Learn to characterize bounded linear functionals on Lp .

• Learn product measure and their completion.

## MTH4C15 ADVANCED FUNCTIONAL ANALYSIS

Course Outcomes: Upon the successful completion of the course students will:

• Understand the concept of the spectrum of bounded operators and how much it will be helpful in solving certain differential equations.

• Get an idea about different types of convergence of sequences in normed spaces and their relations.

• Understand that there is a nice class of operators called compact linear operators stronger than continuous linear operators on a normed space and understand the behavior of spectrum of such operators.

• Understand that there is a surjective isometry between a Hilbert space and its dual.

## MTH4E07: ALGEBRAIC TOPOLOGY

Course Outcomes: Upon the successful completion of the course students will:

• Learn how basic geometric structures may be studied by transforming them into algebraic questions.

• Learn basics of homology theory and apply it to get a generalization of Euler's formula to a general polyhedra.

• Learn to associate various groups namely homology groups of various dimensions and the homotopy group- the fundamental group to every topological space.

• Learn that two objects that can be deformed into one another will have the same homology group.

• Learn Brouwer fixed point theorem and related results.

## MTH4E08: COMMUTATIVE ALGEBRA

Course Outcomes: Upon the successful completion of the course students will:

• Learn basic properties of commutative rings, ideals and modules over commutative rings,

• Learn uniqueness theorem for a decomposable ideal.

• Learn integrally closed domain and valuation ring.

• Understand the basic theory of Noetherian and Artin Rings

## MTH4E09: DIFFERENTIAL GEOMETRY

Course Outcomes: Upon the successful completion of the course students will:

• Understand how calculus of several variables can be used to develop the geometry of ndimensional oriented n- surface in $\mathbb{R}n$+1 .

• Understand locally n- surfaces and parametrized n- surfaces are the same.

• Develop a knowledge of the Gauss and Weingarten maps and apply them to apply them to describe various properties of surfaces.

## MTH4E11: GRAPH THEORY

Course Outcomes: Upon the successful completion of the course students will:

• Understand the trees, Euler tour and Hamilton cycle and some of their applications

• Learn Matchings and Coverings in Bipartite Graphs.

• Understand directed graph planar graph and their properties.

## MTH4E12 REPRESENTATION THEORY

Course Outcomes: Upon the successful completion of the course students will:

• Acquire the basics of classical representation theory of finite groups.

• Understand character theory and orthogonal relations.

• Acquire a knowledge of the theory of induced characters.

## MTH4E13: WAVELET THEORY

Course Outcomes: Upon the successful completion of the course students will:

• Learn the concept of discrete Fourier Transforms and its basic properties.

• Learn how to construct Wavelets on $\mathbb{Z}N$ and $\mathbb{Z}$.

• Learn Wavelets on $\mathbb{R}$ and construction of MRA.