# Sree Narayana Mangalam College Maliankara

*(Affiliated to Mahatma Gandhi University, Kottayam)*

## PROGRAMME OUTCOME

## PROGRAMME SPECIFIC OUTCOME, COURSE OUTCOME

# MSc Mathematics

**Sree Narayana Mangalam College**
**Maliankara P.O, Moothakunnam (Via),**
**Ernakulam (Dt), Kerala, Pin – 683516**
**snmciqac@gmail.com 0484-2483600**
**www.snmcollege.ac.in**

# POST GRADUATE PROGRAMME OUTCOMES

At the end of the Post Graduate Program at S.N.M College, Maliankara, a student will have developed:

| | |
|---|---|
| **PO1:** | **Subject competence and Problem Solving:** Understanding the respective subject matter to become subject experts in the field and solve problems of relevance to society to meet the specified needs using the knowledge, skills and attitudes acquired from the program of study is the sole intention of this program outcome. It enables the student at viewing multiple perspectives to analyze any situation/task at hand and derive feasible solutions by optimistically approaching a problem. This inculcates independent research aptitudes and strong decision |
| **PO2:** | **Research-related skills:** A sense of inquiry and capability for asking relevant/appropriate questions, problem solving, synthesizing and articulating; Ability to recognise cause-and-effect relationships, define problems, formulate hypotheses, test hypotheses, analyse, interpret and draw conclusions from data, establish hypotheses, predict cause-and-effect relationships; ability to plan, execute and report the results of an experiment or investigation. |
| **PO3:** | **Cooperation/Team work:** Ability to work effectively and respectfully with diverse teams; facilitate cooperative or coordinated effort on the part of a group, and act together as a group or a team in the interests of a common cause and work efficiently as a member of a team. |
| **PO4:** | **Analytical reasoning:** Ability to evaluate the reliability and relevance of evidence; identify logical flaws and holes in the arguments of others; analyze and synthesize data from a variety of sources; draw valid conclusions and support them with evidence and examples, and addressing opposing viewpoints. |
| **PO5:** | **Scientific Reasoning:** Ability to analyze, interpret and draw conclusions from quantitative/qualitative data; and critically evaluate ideas, evidence and experiences from an open-minded and reasoned perspective. |
| **PO6:** | **Self-directed Learning**: Ability to work independently, identify appropriate resources required for a project, and manage a project through to completion. |
| **PO7:** | **Critical Thinking:** Capability to apply analytic thought to a body of knowledge; analyze and evaluate evidence, arguments, claims, beliefs on the basis of empirical evidence; identify relevant assumptions or implications; formulate coherent arguments; critically evaluate practices, policies and theories by following scientific approach to knowledge development. |

## PROGRAMME SPECIFIC OUTCOMES

At the end of MSc Mathematics at S.N.M College, Maliankara, a student will have developed:

| | |
|---|---|
| **PSO1** | **Advanced Mathematical Knowledge**: Graduates will demonstrate a deep understanding of advanced mathematical concepts and theories in areas such as algebra, calculus, differential equations, complex analysis, discrete mathematics, and numerical methods.. |
| **PSO2** | **Problem-Solving Skills**: Students will be equipped with the ability to apply mathematical techniques and methodologies to solve complex real-world problems in various fields, including science, engineering, finance, and data analysis |
| **PSO3:** | **Proficiency in Mathematical Software**: Graduates will be proficient in using specialized programming language Python. |
| **PSO4:** | **Research and Analytical Abilities**: Graduates will be capable of conducting independent research in mathematics, including formulating hypotheses, designing experiments or proofs, analyzing data, and drawing valid conclusions. . |
| **PSO5:** | **Mathematical Modeling:** Students will gain expertise in formulating mathematical models to represent and analyze real-world phenomena, enabling them to make predictions, optimize processes, and simulate various scenarios. |

## COURSE OUTCOMES

### ME010101- ABSTRACT ALGEBRA

On successful completion of the course, a student will be able to

| | |
|---|---|
| **CO1:** | Understand and apply the concept of direct products and finitely generated Abelian groups, and solve problems related to their fundamental theorem. |
| **CO2:** | Analyze and apply group actions on sets, including identifying isotropy subgroups and using G-sets for counting and combinatorial applications. |
| **CO3:** | Apply isomorphism theorems and Sylow theorems to study and classify groups, and utilize the Sylow theory for various applications. |
| **CO4:** | Demonstrate an understanding of non-commutative examples and their significance in abstract algebra. |
| **CO5:** | Identify and work with prime and maximal ideals in rings. |

### ME010102- LINEAR ALGEBRA

At the end of this course, a student will have developed ability to:

| | |
|---|---|
| **CO1:** | Recall vector spaces, subspaces, basis and dimension and understanding coordinates and summary of row equivalence. |
| **CO2:** | Understand linear transformations their algebra and representation of transformations by matrices. |
| **CO3:** | Assimilate ideas of canonical forms, characteristic values and annihilating polynomials |
| **CO4:** | Develop ideas of simultaneous triangulation and diagonalisation and direct sum decomposition. |

## ME010103- BASIC TOPOLOGY

At the end of this course student will have following benefits:

| | |
|---|---|
| **CO1:** | Gain a solid understanding of fundamental topological concepts, including open sets, closed sets, neighborhoods, continuity, compactness, connectedness, and the notion of topological equivalence. Analyse the concept of Topological spaces, base and subbase |
| **CO2:** | Develop the ability to construct and present clear and logical proofs related to basic topological properties and theorems. Apply the concept of continuity and quotient spaces on different topology. |
| **CO3:** | Understand the concept of local connectedness and path connected. |
| **CO4:** | Students would understand trends in various sectors of Indian Economy. |
| **CO5:** | Differentiate levels of spaces based on axioms. |

## ME010104- REAL ANALYSIS

At the end of this course, a student will have developed ability to:

| | |
|---|---|
| **CO1:** | Understanding functions of bounded variation, total variation, additive property of total variation and their properties. |
| **CO2:** | Familiarizing rectifiable path and arc length, additive and continuity properties of arc length, equivalence of paths and change of parameter. |
| **CO3:** | Understanding and use the basic concepts and properties of the Riemann - Stieltjes Integral and integration vector valued functions. |
| **CO4:** | Attainment of a deeper and wider knowledge of Sequence and Series of Functions and uniform convergence.. |
| **CO5:** | A deeper Knowledge on Weierstrass Approximation Theory and algebraic completeness of complex field. |

## 10105 - GRAPH THEORY

At the end of this course, a student will have developed ability to:

| | |
|---|---|
| **CO1:** | Understand the fundamentals of graph theory, Analyze subgraphs and degrees of vertices, Explore paths and connectedness, Define automorphisms and understand their significance in graph theory, Perform operations on graphs and understand graph products, Gain proficiency in directed graphs. |
| **CO2:** | Understand Connectivity and Related Concepts, Comprehend Blocks and Cyclical Edge Connectivity, Grasp the Fundamentals of Trees, Explore Centres and Cancroids in Trees, Count Spanning Trees and Apply Cayley's Formula, Apply Connectivity and Trees in Practical Scenarios, Develop Problem-solving and Analytical Skills. . |
| **CO3:** | Understand the Fundamentals of Eulerian and Hamiltonian Graphs, Apply Eulerian and Hamiltonian Concepts in Real-World Scenarios, Comprehend Graph Colorings and Chromatic Numbers, Analyze Graph Coloring Algorithms and Applications, Understand Critical Graphs and Brooks' Theorem, Apply Graph Theory Concepts to Problem-Solving. |
| **CO4:** | Define and Identify Planar and Nonplanar Graphs, Understand Euler's Formula and Its Consequences, Identify Nonplanar Graphs and Kuratowski's Theorem, Comprehend the Concept of Dual Graphs, Explore the Four-Color Theorem and the Heawood Five-Color, Introduction to Spectral Properties of Graphs, Analyze the Spectrum of the Complete Graph Kn, Investigate the Spectrum of the Cycle Graph Cn. |

## ME010201- ADVANCED ABSTRACT ALGEBRA

On successful completion of the course, a student will be able to

| | |
|---|---|
| **CO1:** | Demonstrate a thorough understanding of extension fields, algebraic extensions, and geometric constructions, and apply these concepts to solve problems involving finite fields. |
| **CO2:** | Analyze and apply the properties of unique factorization domains, Euclidean domains, and Gaussian integers with multiplicative norms to factorize integers and polynomials. |
| **CO3:** | Understand and utilize automorphisms of fields, the isomorphism extension theorem, and splitting fields to study the structure and properties of algebraic extensions. |
| **CO4:** | Comprehend the concept of separable extensions and acquire a deep knowledge of Galois Theory, including understanding Galois groups, normal subgroups, and fundamental theorems related to Galois Theory. |
| **CO5:** | Demonstrate proficiency in illustrating Galois Theory through concrete examples and applications, such as solving polynomial equations and determining constructible polygons. |

## ME010202- ADVANCED TOPOLOGY

At the end of this course, a student will have developed ability to:

| | |
|---|---|
| **CO1:** | Explain the concepts of Separation axioms and Tietze Characterisation of normality. |
| **CO2:** | Demonstrate Cartesian products of families of sets |
| **CO3:** | Analyze and describe the topological properties of various spaces, both abstract and concrete, using techniques such as open sets, compactness, connectedness, and separation axioms. Discuss Urysohn's metrization theorem |
| **CO4:** | Analyse convergence of nets and homotopy of paths. Strong analytical and problem-solving skills, enabling them to construct rigorous proofs related to advanced topological theorems and concept |

## ME010203- NUMERICAL ANALYSIS WITH PYTHON3

At the end of this course student will have following benefits

| | |
|---|---|
| **CO1:** | Explain numerical packages like PYTHON |
| **CO2:** | Solve Calculus problems using PYTHON |
| **CO3:** | Compare method of bisection and Newton Raphson method to find roots of an equation |
| **CO4:** | Apply Gauss Elimination method in solving linear equations |
| **CO5:** | Interpret calculation and interpretation of errors in numerical method. |

:

## ME010204- COMPLEX ANALYSIS

At the end of this course, a student will have developed ability to:

| | |
|---|---|
| **CO1:** | Students will gain a solid foundation in complex analysis, enabling them to understand and manipulate complex functions, explore their geometrical properties, and apply these concepts to various mathematical and engineering problems. |
| **CO2:** | Students will gain a comprehensive understanding of the fundamental theorems and integral formulas in complex analysis, enabling them to solve a wide range of complex integration problems, analyze complex functions, and apply these concepts to various practical and theoretical scenarios. They will also develop critical thinking skills and the ability to apply abstract mathematical concepts to real-world applications. This course will serve as a solid foundation for further studies in advanced complex analysis and its applications in mathematics, engineering, physics, and other related fields. |
| **CO3:** | Students will gain a comprehensive understanding of advanced concepts in complex analysis, enabling them to analyze the properties and behavior of analytical functions, compute higher derivatives, and apply the fundamental theorems and integral formulas in various mathematical and engineering applications. They will also develop critical thinking skills and the ability to apply abstract mathematical concepts to solve practical and theoretical problems in complex analysis. |
| **CO4:** | Students will gain a strong foundation in complex analysis, enabling them to apply Cauchy's Theorem and the calculus of residues to solve a wide range of complex integration problems. They will develop the ability to analyze the behavior of complex functions, identify closed curves, and compute residues for singular points |

# ME010205- MEASURE THEORY AND INTEGRATION

At the end of this course, a student will have developed ability to:

| | |
|---|---|
| **CO1:** | Introduce Lebesgue Measure, use the concepts of outer measure, measurable sets and measurable functions. |
| **CO2:** | Describe differentiation of monotone functions, state and explain the construction of the Lebesgue integral and use it. |
| **CO3:** | Apply the theorems of monotone and dominated convergence and Fatou's lemma |
| **CO4:** | Introduce Measure spaces, Measurable function Explain outer measure and measurability. Introduce signed measures and decomposition theorems.. |
| **CO5** | Explain measurability in a product space, construct the product measure and to apply Fubini's and Tonelli theorem. Apply Lebesgue decomposition and the Radon-Nikodym theorem. |

## ME010301- ADVANCED COMPLEX ANALYSIS

At the end of this course student will have following benefits:

| | |
|---|---|
| **CO1:** | students will gain a strong understanding of harmonic functions and their properties, enabling them to solve complex analysis problems involving boundary value problems, Poisson's formula, and Schwarz's Theorem. They will develop the ability to analyze functions with the Mean-Value Property and apply Harnack's Principle to analyze harmonic functions in bounded regions. Additionally, students will learn to solve boundary value problems for Laplace's equation using subharmonic functions and understand the application of harmonic functions in various engineering and physical contexts. ... |
| **CO2:** | Students will develop a solid understanding of complex analysis topics related to power series, partial fractions, and entire functions. They will gain the ability to compute power series expansions, analyze the convergence of functions, and represent complex functions using different forms, including partial fractions and infinite products. Additionally, students will learn how to analyze entire functions, compute zeros, and understand their growth behavior, laying a strong foundation |
| **CO3:** | Students will gain a comprehensive understanding of the Riemann Zeta Function and its properties, including its analytic continuation to the whole complex plane, its functional equation, and the distribution of its zeroes. They will also develop the ability to analyze and apply normality and compactness concepts to families of holomorphic functions. This course will serve as a solid foundation for further studies in complex analysis, number theory, and related fields, and it will provide students with the mathematical tools to tackle more advanced problems involving the Riemann Zeta Function and normal families of holomorphic functions. |
| **CO4:** | Students will gain a comprehensive understanding of the Riemann Mapping Theorem and its proof, enabling them to analyze the existence and uniqueness of conformal mappings between simply connected regions. They will also develop the ability to apply conformal mappings to extend functions across the boundaries of regions using the Reflection |

## ME010302- PARTIAL DIFFERENTIAL EQUATIONS

At the end of this course, a student will have developed ability to:

| | |
|---|---|
| **CO1:** | Form first order PDE, find orthogonal trajectories of a system of curves on a surface and find the solution of Pfaffian differential equations |

| | |
|---|---|
| **CO2:** | Solve linear PDE of both first and second. |
| **CO3:** | Form Second order PDE and solve linear PDE with constant coefficients and that with variable coefficients |
| **CO4:** | Apply technique of separation of variables to solve PDEs, Solve non-Linear PDE and find elementary solutions of Laplace equations |

## ME010303 - MULTIVARIATE CALCULUS AND INTEGRAL

At the end of this course, a student will have developed ability to:

| | |
|---|---|
| **CO1:** | Understand the basic results in the analysis of functions of several variables. |
| **CO2:** | Understand the fundamental transforms, convolutions. Recognise vector valued functions and relate directional derivatives and partial derivatives to total derivative |
| **CO3:** | Understand implicit functions and extremum problems |
| **CO4:** | Recognise primitive mappings and differential forms. Explain Weirstrass Theorem |

## ME010304- FUNCTIONAL ANALYSIS

At the end of this course, a student will have developed ability to:

| | |
|---|---|
| **CO1:** | Understand and analyse various problems in different space: vector space, inner product space and Hilbert Spaces |
| **CO2:** | Explain the fundamental concepts of functional analysis. Understand the approximation of continuous functions. |
| **CO3:** | Understand concepts of Hilbert and Banach spaces with $l^2$ and $l^p$ spaces serving as examples |
| **CO4:** | Understand the definitions of linear functional and prove the Hahn-Banach theorem |

# ME010305- OPTIMIZATION TECHNIQUES

At the end of this course, a student will have developed ability to:

| | |
|---|---|
| **CO1:** | Formulate optimization problems. Understand the importance of linear programming problems in which the variables are being restricted to integers |
| **CO2:** | Solve integer programming problems as well as mixed integer linear programming problems. |
| **CO3:** | Apply the methods of optimization in real life situation.. |
| **CO4:** | Identify strategic situations and represent them as games. |

## ME010401- SPECTRAL THEORY

On successful completion of the course, a student will be able to

| | |
|---|---|
| **CO1:** | Prove Open mapping theorem, Category theorem and Uniform Boundedness theorem |
| **CO2:** | Define Strong and Weak Convergence and Convergence of Sequences of Operators. |
| **CO3:** | Understand Spectral Properties of Bounded Linear Operators and Spectral Properties of compact Linear Operators on Normed spaces |
| **CO4:** | Understand Spectral Properties of Bounded Self adjoint linear operators. Define Projection operator and discuss their properties. |

## ME010402- ANALYTIC NUMBER THEORY

At the end of this course, a student will have developed ability to:

| | |
|---|---|
| **CO1:** | Explain arithmetical functions like the Mobius function, Euler totient function Mangoldt function, Liovillie's function etc. |
| **CO2:** | Discuss Chebyshev's functions and identify some equivalent forms of prime number theorem |
| **CO3:** | Describe basic properties of congruences, residue classes and complete residue systems. |
| **CO4:** | Analyse the Chinese remainder theorem and its applications. Describe different inventory models |
| **CO5:** | Interpret model formulation used in solving business decision problems |

## ME810401- PROBABILITY THEORY

At the end of this course, a student will have developed ability to:

| | |
|---|---|
| **CO1:** | Explain different approaches of probability, understand different probability rules and use them to evaluate the probability of a particular event and check the independence of events |
| **CO2:** | Understand the concept of random variable, their types and probability distributions, find expectation, moments and generating functions of different random variables and understand the application of different moment inequalities |
| **CO3:** | Understand the concept of multivariate random variables, check the independence of random variables, find covariance, correlation and moments of bivariate random variables and conditional expectations and understand various rules on expectation of random variables and some well-known inequalities based on expectations |
| **CO4:** | Differentiate between the different types of convergence of sequence of random variables and understand the applications of WLLN, SLLN and CLT. |

## ME810402- OPERATIONS RESEARCH

At the end of this course, a student will have developed ability to:

| | |
|---|---|
| **CO1:** | Solve various types of Dynamic Programming problems |
| **CO2:** | Understand the theory of games for solving simple games |
| **CO3:** | Analyse the performance measures of Queueing models. |
| **CO4:** | Describe different inventory models. Interpret model formulation used in solving business decision problems |

## ME810403- CODING THEORY

At the end of this course, a student will have developed ability to:

| | |
|---|---|
| **CO1:** | Understand the basic definitions and concepts related to error coding theory, such as weights, maximum likelihood decoding, and Syndrom decoding. |
| **CO2:** | Identify and analyze perfect codes and Hamming codes, including their properties and applications. |
| **CO3:** | Analyze the Golay codes and their applications in error correction. |
| **CO4:** | Understand the fundamentals of finite fields and their relevance in error coding theory. |
| **CO5:** | Apply the concepts of cyclic codes and BCH codes to error correction problems. |