M.Sc.Mathematics

Programme Outcomes of M.Sc.

- Acquire interdisciplinary knowledge and the skill of designing and conducting experiments independently in collaboration and interpreting scientific data.
- Communicate effectively, analyze critically and learn to adapt to the socio technological changes.
- Face competitive examinations that offer challenging and rewarding careers in science and education.
- Identify, formulate and critically analyze various scientific problems and design/develop solutions by applying the knowledge to different domains.

PROGRAMME SPECIFIC OUTCOMES (PSO)

PSOs	Upon completion of M.Sc. Mathematics, the graduates will be able to :
PSO - 1	have a strong base in theoretical and applied mathematics.
PSO - 2	sharpen their analytical thinking, logical deductions and rigor in reasoning.
PSO - 3	understand the tools required to quantitatively analyse data and have the ability to access and communicate mathematical information
PSO - 4	write proofs for simple mathematical results.
PSO - 5	acquire knowledge in recent developments in various branches of mathematics and participate in conferences / seminars / workshops etc. and thus pursue research.

Semester : I **Major Core I**

Name of the Course : Algebra I

Subject code : PM1711

No. of hours per week	Credits	Total No. of hours	Marks
6	5	90	100

Objectives: 1. To study abstract Algebraic systems.

2. To know the richness of higher Mathematics in advanced application systems.

CO No.	**Course Outcomes** Upon completion of this course, students will be able to	**POs/PSOs addressed**	**CL**
CO -1	Understand the concepts of automorphism, inner automorphism, Sylow P- subgroups, finite abelian groups, characteristic subgroups for groups	PSO- 2, PSO-3	U

CO -2	Analyze and demonstrate examples of various Sylow P- subgroups, automophisms	PSO- 2, PSO-3	An
CO -3	Develop proofs for Sylow's theorems, Fundamental theorem of finite abelian groups, direct products, Cauchy's theorem, automorphisms for groups.	PSO-3, PSO-4, PSO- 5	C
CO -4	Understand various definitions related to rings and ideals and illustrate	PSO- 2, PSO-3, PSO- 5	U, Ap
CO -5	Develop the way of embedding of rings and design proofs for theorems related to rings	PSO-3, PSO-4, PSO- 5	C
CO -6	Understand the concepts of Euclidean domain and factorization domain and give illustrations.	PSO- 2, PSO-3, PSO- 5	U, Ap
CO -7	Compare Euclidean and Unique factorization domain and Develop the capacity for proving the concepts	PSO-2, PSO-3, PSO- 4	E, An

Teaching Plan

Total contact hours: 75 (Including lectures, assignments and tests)

Unit	**Section**	**Topics**	**Lecture hours**	**Learning outcomes**	**Pedagogy**	**Assessment/evaluation**
I	**Automorphisms and conjugate elements**					
	1.	Automorphism: Definition& Examples, Automorhism of a finite cyclic group, an infinite cyclic group	3	To understand the concept of automorphism and find automorphisms of finite and infinite cyclic groups	Lecture	Test
	2.	Theorems based on automorphism, Inner automorphism	4	To understand the concept of inner automorphism	Lecture	Test
	3.	Problems based on automorphism, Characteristic subgroups: Definition& Examples	3	To understand the concept characteristic sub groups and solve problems based on the concept	Group Discussin	Quiz
	4.	Conjugate Elements: Definition and Theorems, Cojugate class: Definition and Cauchy Theorem, Similar Permutation: Definition and Theorems	3	To understand the concepts and give illustrations	Seminar	Formative Assessment Test I
II	**Sylow's theorems and Direct products**					
	1.	Definition, Theorems and problems based on p-group	3	To understand the concept and give illustrations	Lecture	Test
	2.	Sylow's first theorem, Sylow's second theorem, Sylow's third	3	To understand the concept of Sylow P- subgroups and analyze various Sylow P-	Lecture	Test

		theorem		subgroups		
	3.	Theorems and Problems based on Sylow's theorem	3	To develop proofs for theorems based on Sylow P-subgroups	Lecture	Formative Assessment Test I, II
	4.	Direct products: Definition, Examples and Theorems	4	To understand the concept and give illustrations	Seminar	Test
	5.	Theorems based on finite abelian groups and invarients	4	To understand the concept and give illustrations	Lecture	Test
III	**Rings**					
	1.	Rings: Definition , Examples and Theorems integral domain: Theorems & Problems	3	To understand the concept and practice theorems	Lecture With PPT	Test
	2.	Subrings, Quaternion ring, Subdivision ring,: Definition, Examples, & Theorems	3	To understand the concept and develop theorems	Group Discussion	Test
	3.	Characteristic of a ring: Definition, Examples, Theorems & Problems	4	To understand the concept and analyze theorems	Lecture	Test
	4.	Ideals, sum of ideals, product of ideals and division ring: Definition, Examples, Theorems	5	To understand the concept and demonstrate examples.	Lecture	Formative Assessment Test II
IV	**Homomorphisms and embedding of Rings**					
	1.	Quotient Rings, Homomorphisms: Definition , Examples and Theorems	3	To understand the concepts Quotient Rings, Homomorphisms and give illustrations	Lecture with illustration	Test
	2.	Fundamental theorem of ring homomorphism , First theorem of Isomorphism, Second theorem of Isomorphism & Theorems related to ring of ideals	3	To understand the concept and practice theorems related to the concepts.	Lecture	Test
	3.	Embedding of rings: Ring into a Ring with unity, Ring into a Ring with endomorphisms, Integral domain embedded into a field and related theorems	4	To develop the way of embedding of rings and design proofs for theorems related to rings	Group Discussion	Test
	4.	Comaximal ideals, Maximal ideals and Prime ideals: Definition	5	To understand various definitions related to ideals and illustrate	Seminar	Formative Assessment Test III

		& Theorems				
V	**Euclidean and Factorization Domains**					
	1.	Euclidean Domain, Principal ideal domain: Definition and Theorems	5	To understand the concepts of Euclidean domain and factorization domain and give illustrations.	Lecture	Test
	2.	Prime and irreducible elements, Polynomial rings: Definitions & Theorems	4	To understand concepts and practice theorems related to the concepts	Lecture	Formative Assessment Test III
	3.	Greatest Common Divisor, Unique factorization Domains: Definitions, Examples & Theorems	3	To compare Euclidean and Unique factorization domain and develop the capacity for proving the concepts	Seminar	Assignment
	4.	Gauss Lemma, Theorems based on irreducible element and irrudicible polynomial	3	To practice theorems based on this concepts	Lecture	Assignment

Course Instructor (Aided): Dr.S.Sujitha HOD(Aided) :Dr. V. M. Arul Flower Mary Course Instructor(S.F): Ms. V. Princy Kala HOD(S.F) :Ms. Anne Mary Leema

Semester : I **Major Core II**

Name of the Course : Analysis I

Subject code : PM1712

No. of hours per week	Credits	Total No. of hours	Marks
6	4	90	100

Objectives:

1. To understand the basic concepts of analysis.

2. To formulate a strong foundation for future studies.

Course Outcomes

CO	Upon completion of this course the students will be able to :	PSO addressed	CL
CO -1	Explain the fundamental concepts of analysis and their role in modern mathematics.	PSO- 2, PSO-3	U

CO -2	Deal with various examples of metric space, compact sets and completeness in Euclidean space.	PSO- 2, PSO-3	An
CO -3	Learn some techniques for testing the convergence of sequence and series and confidence in applying them.	PSO- 2, PSO- 3	U
CO -4	Understand the Cauchy's criterion for convergence of real and complex sequence and series	PSO- 2, PSO- 3	U
CO -5	Apply the techniques for testing the convergence of sequence and series	PSO- 2, PSO-3	An
CO -6	Understand the important theorems such as Intermediate valued theorem, Mean value theorem, Roll's theorem, Taylor and L'Hospital theorem	PSO- 2, PSO-3	U
CO -7	Apply the concepts of differentiation in problems.	PSO- 5	Ap

Teaching Plan

Total contact hours: 75 (Including lectures, assignments and tests)

Unit	**Module**	**Topics**	**Lecture hours**	**Learning Outcomes**	**Pedagogy**	**Assessment/ evaluation**
I	**Basic Topology**					
	1	Definitions and examples of metric spaces, Theorems based on metric spaces.	5	To explain the fundamental concepts of analysis and also todeal with various examples of metric space.	Lecture	Test
	2	Definitions of compact spaces and related theorems, Theorems based on compact sets	5	To understand the definition of compact spaceswith examples and theorems	Lecture	Test
	3	Weierstrass theorem, Perfect Sets, The Cantor set	3	To understand the concepts of Perfect Sets and The Cantor set	Lecture	Test
	4	Connected Sets and related problems	2	To understand the definitionof Connected Setsand practice various problems.	Lecture	Formative Assessment Test I
II	**Convergent Sequences**					
	1	Definitions andtheorems of convergent sequences, Theorems based on convergent sequences	5	To Learn some techniques for testing the convergence of sequence.	Lecture	Test

	2	Theorems based on Subsequences	2	To understand the concept of Subsequences with theorems	Lecture	Formative Assessment Test I, II
	3	Definition and theorems based on Cauchy sequences, Upper and lower limits	5	To Understand the definition and theorems based on Cauchy sequences	Lecture	Test
	4	Some special sequences, Problems related to convergent sequences	3	To Understand the problems related to convergent sequences	Lecture	Test
III	**Series**					
	1	Series, Theorems based on series	3	To Learn some techniques for testing the convergence series and confidence in applying them	Lecture	Test
	2	Series of non-negative terms, The number e	4	To find the number e	Lecture	Assignment
	3	The ratio and root tests – example and theorems, Power series	3	To Understand the ratio and root tests	Lecture	Quiz
	4	Summation of parts, Absolute convergence	2	To apply the techniques for testing the absolute convergence of series	Lecture	Test
	5	Addition and multiplication of series, Rearrangements	3	To find theAddition and multiplication of series	Lecture with group disscussion	Test
IV	**Continuity**					
	1	Definitions and Theorems based on Limits of functions, Continuous functions	4	To explain the fundamental concepts of analysis and their role in modern mathematics	Lecture with PPT	Test
	2	Theorem related to Continuous functions, Continuity and Compactness	3	To Understand the theorem related to Continuous functions	Lecture	Test

	3	Corollary, Theorems based on Continuity and Compactness, Examples and Remarks related to compactness	3	To Understand the concepts of Continuity and Compactness	Lecture	Formative Assessment
	4	Continuity and connectedness, Discontinuities	2	To Understand the definition of Continuity and connectedness	Lecture	Assignment
	5	Monotonic functions, Infinite limits and limits at infinity	3	To Understand the definition of Monotonic functions, Infinite limits and limits at infinity	Lecture	Test
V	**Differentiation**					
	1	The derivative of a real functions - Theorems, Examples	3	To Apply the concepts of differentiation	Lecture	Test
	2	Mean value theorems	3	To Understand the important Mean value theorem	Lecture	Test
	3	The continuity of derivatives, L'Hospital rule, Derivatives of higher order, Taylor's Theorem	4	To Understand the important theorems such as Taylor and L'Hospital theorem	Lecture with group discussion	Quiz
	4	Differentiation of vector valued functions	3	To Understand the concepts of differentiation	Lecture	Formative Assessment
	5	Problems related to differentiation	2	To Apply the concepts of differentiation in problems.	Lecture	Assignment

Course Instructor (Aided): Ms.Afina Resalaiyan HOD(Aided) :Dr. V. M. Arul Flower Mary Course Instructor(S.F): Ms. R. N. Rajalekshmi HOD(S.F) :Ms. Anne Mary Leema

Semester **: I** **Major Core III**

Name of the Course **: Probability and Statistics**

Subject code **: PM1713**

No. of hours per week	Credits	Total no. of hours	Marks
6	4	90	100

Objective:

To upgrade the knowledge in Probability theory for solving NET / SET related Statistical problems.

Course Outcomes

CO	Upon completion of this course the students will be able to :	PSO addressed	CL
CO- 1	Recall the basic probability axioms,conditional probability, random variables and related concepts	PSO-1	R
CO- 2	Compute marginal and conditional distributions and check the stochastic independence	PSO-2, PSO-3	U, Ap
CO- 3	Repeat Binomial, Poisson and normal distributionsand learn new distributions such as multinomial, Chi square and Bivariate normal distribution	PSO-1, PSO- 2, PSO-3	R,U
CO- 4	Learn the transformation technique for finding the p.d.f of functions of random variables and use these techniques to solve related problems	PSO-2, PSO-3, PSO-5	U, Ap
CO -5	Employ the relevant concepts of analysis to determine limiting distributions of random variables	PSO-5	Ap
CO- 6	Design probability models to deal with real world problems and solve problems involving probabilistic situations.	PSO- 3, PSO-4, PSO-5	C,Ap

Teaching Plan

Total contact hours: 75 (Including lectures, assignments and tests)

Unit	Module	Topics	Lecture hours	Learning outcomes	Pedagogy	Assessment/evaluation
I	**Conditional probability and Stochastic independence**					
	1	Definition of Conditional probability and multiplication theorem Problems on Conditional probability Bayre's Theorem	4	Explain the primary concepts of Conditional probability	Lecture with Illustration	Evaluation through appreciative inquiry

	2	Definition and calculation of marginal distributions Definition and calculation of conditional distributions Conditional expectations	4	To distinguish between marginal distributions and conditional distributions	Lecture	Evaluation through quizzes and discussions.
	3	The correlation coefficient Derivation of linear conditional mean Moment Generating function of joint distribution Stochastic independence of random Variables and related problems	4	To understand the theorems based onStochastic independence of random Variables	Lecture with Illustration	Slip Test
	4	Necessary conditions for stochastic independence. Necessary and sufficient conditions for stochastic independence. Pairwise and mutual stochastic independence. Bernstein's example.	3	To understandthe necessary and sufficient conditions for stochastic independence	Discussion with Illustration	Quiz and Test
II	**Some special distributions**					
	1	Derivation of Binomial distribution M.G.F and problems related to Binomial distribution Law of large numbers Negative Binomial distribution	4	To understand Law of large numbers Negative Binomial distribution	Lecture with Examples	Evaluation through discussions.
	2	Trinomial and multinomial distributions Derivation of Poisson distribution using Poisson postulates M.G.F and problems related to Poisson distribution Derivation of Gamma distribution using Poisson postulates	4	To know aboutDerivation of Poisson distribution using Poisson postulates	Lecture	Evaluation through appreciative inquiry
	3	Chi-Square distribution and its M.G.F Problems on Gamma and Chi-Square distributions The Normal distribution	4	To identify Chi-Square distribution and its M.G.F Problems on Gamma and Chi-Square distributions The Normal distribution	Lecture	Formative Assessment Test

	4	Derivation of standard Normal distribution M.G.F and problems on Normal distribution The Bivariate Normal distribution Necessary and sufficient condition for stochastic independence of variables having Bivariate Normal distribution	4	Relate the Normal distribution and stochastic independence of variables having Bivariate Normal distribution	Group Discussion	Slip Test
III	**Distributions of functions of random variables**					
	1	Sampling theory Sample statistics and related problems Transformations of single variables of discrete typeand related problems	4	Explain the primary concepts of Sampling theory Sample statistics	Lecture with Illustration	Evaluation through discussions.
	2	Transformations of single variables of continuous typeand related problems Transformations of two or more variables of discrete typeand related problems	4	To understand Transformations of single variables and Transformations of two or more variables	Lecture with Illustration	Evaluation through appreciative inquiry
	3	Transformations of two or more variables of continuous type and related problems Derivation of Beta distribution	3	Explain the derivation of Beta distribution	Lecture	Formative Assessment Test
	4	Derivation of t distribution Problems based on t distribution ,Derivation of F distribution Problems based on F distribution	4	To identify the t distribution and F distribution	Group Discussion	Slip Test
IV	**Extension of change of variable technique**					
	1	Change of variable technique for n random variables Derivation of Dirichlet distribution Transformation technique for transformations which are not 1-1	4	Explain the primary concepts of Change of variable technique for n random variables	Lecture with Illustration	Evaluation through discussions.
	2	Joint p.d.f. of Order	4	To understand the	Lecture and	Evaluation

		Statistics, Marginal p.d.f. of Order Statistics, Problems on Order Statistics		Problems on Order Statistics	group discussion	through Assignment
	3	The moment generating function technique and related theorems, Problems based on moment generating function technique	3	To know about moment generating function technique and related theorems	Lecture with Illustration	Formative Assessment Test
	4	Distributions of $\bar{x}$ and nS^2 /σ^2,Problems based on the distributions of $\bar{x}$ and nS^2 /σ^2 ,Theorems on expectations of functions of. Random variables, Problems on expectations of functions of. Random variables	4	To solve the Problems based on the distributions of $\bar{x}$ and nS^2 /σ^2	Lecture with Illustration	Slip Test
V	**Limiting distributions**					
	1	Behavior of distributions for large values of n Limiting distribution of n^{th} order statistic Limiting distribution of sample mean from a normal distribution	3	Explain the behavior of distributions for large values of n	Lecture with Illustration	Evaluation through discussions.
	2	Stochastic convergence and convergence in probability Necessary and sufficient condition for Stochastic convergence, Limiting moment generating function	4	To understand necessary and sufficient condition for Stochastic convergence Limiting moment generating function	Lecture with Illustration	Formative Assessment test
	3	Computation of approximate probability The Central limit theorem	3	To understand The Central limit theorem	Lecture with Illustration	Slip Test
	4	Problems based on the Central limit theorem Theorems on limiting distributions Problems on limiting distributions	4	To calculate Problems based on the Central limit theorem and Problems on limiting distributions	Lecture with Illustration	Home Assignment

Course Instructor (Aided): Ms.J.C.Mahizha HOD(Aided) :Dr. V. M. Arul Flower Mary Course Instructor(S.F): Ms. S. Kavitha HOD(S.F) :Ms. Anne Mary Leema

Semester **: I** **Major Core IV**

Name of the Course **: Ordinary differential equations**

Subject code **: PM1714**

No. of hours per week	Credits	Total no. of hours	Marks
6	4	90	100

Objectives:

1. To study mathematical methods for solving differential equations

2. Solve dynamical problems of practical interest.

Course Outcomes

CO	Upon completion of this course the students will be able to :	PSO addressed	CL
CO-1	Recall the definitions of degree and order of differential equations and determine whether a system of functions is linearly independent using the Wronskian	PSO- 1, PSO- 2, PSO-3	R,U
CO-2	Solve linear ordinary differential equations with constant coefficients by using power series expansion	PSO- 5	Ap
CO-3	Determine the solutions for a linear system of first order equations	PSO- 2, PSO-3	U
CO- 4	Learn Boundary Value Problems and find the Eigen values and Eigen functions for a given Sturm Liouville Problem	PSO- 2, PSO-3	U
CO-5	Analyze the concepts of existence and uniqueness behaviour of solutions of the ordinary differential equations	PSO- 2, PSO-3	An
CO-6	Create differential equations for a large number of real world problems	PSO- 3, PSO-4, PSO-5	C

Teaching Plan

Total contact hours: 75 (Including lectures, assignments and tests)

Unit	Module	Topics	Lecture hours	Learning outcomes	Pedagogy	Assessment/evaluation
I	**Second Order linear Equations**					
	1	Second order Linear Equations - Introduction	4	Understand the concepts of existence and uniqueness behaviour of solutions of the ordinary differential	Lectures, Assignments	Test

				equations		
	2	The general solution of a homogeneous equations	4	To understand the theorems and identify whether a system of functions is linearly independent using the Wronskian	Lectures, Assignments	Test
	3	The use of a known solution to find another	4	To determine the solutions for the Second order Linear Equations	Lectures, Assignments	Test
	4	The method of variation of parameters Variation of parameters	4	To determine the solutions using the method of variation of parameters	Lectures, Seminars	Test
II	**Power series solutions**					
	1	Review of power series, Series solutions of first order equations	4	To learn about Power Series method	Lectures, Assignments	Test
	2	Power Series solutions for Second order linear equations	3	To determine solutions for Series solutions of first order equations	Lectures, Seminars	Test
	3	Ordinary points, Singular points	3	To understand the concepts Ordinary points and Singular points	Lectures, Group Discussion	Quiz
	4	Regular singular points	5	To solve linear ordinary differential equations with constant coefficients by using Frobenius method	Group Discussion	Test
III	**System of Equations**					
	1	Linear systems-theorems	4	To understand the theorems in Systems of Equations	Lectures, Online Assignments	Test
	2	Linear systems-problems	3	To determine the solutions for a linear system of first order equations	Online Assignments	Test
	3	Homogeneous linear systems with constant coefficients	3	To understand the theorems Homogeneous linear systems with constant coefficients	Seminars	Test
	4	Homogeneous linear systems with constant coefficients– problems	3	To determine the solutions for Homogeneous linear systems with constant coefficients	Group Discussions, Online Assignments	Test
IV	**Picard's method of Successive approximations**					
	1	The method of Successive approximations	4	To solve the problems using the method of Successive approximations	Lectures, Assignments	Test
	2	Picard's theorem	3	To understand the Picard's theorem	Lectures	Test
	3	Lipchitz condition	5	To solve problems using	Lectures,	Quiz

				Lipchitz condition	Group discussion	
	4	Systems-The second order linear equations	2	To solve the problems in Systems of second order linear equations	Assignments	Assignment
V	**Boundary Value Problems**					
	1	Introduction, definitions and examples	3	To differentiate Boundary Value Problems and initial value problems	Lectures, Group discussion	Quiz
	2	Sturm Liouville problem	3	To find the Eigen values and Eigen functions for a given Sturm Liouville Problem	Lectures, Assignments	Test
	3	Green's functions	4	To understand the theorems on Green's functions and apply in solving problems	Lectures	Test
	4	Non existence of solutions	5	To compare existence and non existence of solutions	Lectures, Seminars	Assignment

Course Instructor (Aided): Dr.J.Befija Minnie HOD(Aided) :Dr. V. M. Arul Flower Mary Course Instructor(S.F): Ms. J. Anne Mary Leema HOD(S.F) :Ms. J. Anne Mary Leema

Semester : I

Name of the Course : Numerical Analysis **Elective I**

Subject Code : PM1715

No. of hours per week	Credits	Total No. of hours	Marks
6	4	90	100

Objectives:

1. To study the various behaviour pattern of numbers.

2. To study the various techniques of solving applied scientific problems.

Course Outcomes

CO No.	Upon completion of this course, the students will be able to :	PSO addressed	CL
CO- 1	Recall about finding the roots of the algebraic and transcendental equations using algebraic methods.	PSO- 1	R
CO- 2	Derive appropriate numerical methods to solve algebraic and transcendental equations.	PSO-5	Ap
CO- 3	Understand the significance of the finite, forward, backward and central differences and their properties.	PSO-2, PSO-3	U
CO -4	Draw the graphical representation of the each numerical method.	PSO-5	Ap

CO- 5	Solve the differential and integral problems by using numerical methods. (Eg. Trapezoidal rule, Simpson's rule etc.)	PSO-5	Ap
CO -6	Solve the problems in ODE by using Taylor's series method, Euler's method etc.	PSO-5	Ap
CO -7	Differentiate the solutions by Numerical methods with exact solutions.	PSO-3, PSO-4, PSO-5	C
CO -8	Compute the solutions of the system of equations by using appropriate numerical methods.	PSO-5	Ap

Teaching Plan

Total contact hours: 75 (Including lectures, assignments and tests)

Unit	**Module**	**Topics**	**Lecture hours**	**Learning outcomes**	**Pedagogy**	**Assessment/evaluation**
I	**Solution of Algebraic and Transcendental Equations**					
	1	Bisection Method - Examples and graphical representation, Problems based on Bisection Method	3	Recall about finding the roots of the algebraic and transcendental equations using algebraic methods.	Lecture	Evaluation through test
	2	Method of False Position – Examples and graphical representation, Problems based on Method of False Position, Iteration Method – Examples and graphical representation	3	Draw the graphical representation of the each numerical method.	Lecture with Illustration	Evaluation through test
	3	Problems based on Iteration Method, Acceleration of Convergence: Aitken's Δ^2 Process,	3	To understand the Acceleration of Convergence	Lecture with Illustration	Test
	4	Newton-Raphson Method and graphical representation, Problems based on Newton-Raphson Method, Generalized Newton's method,	3	To solve algebraic and transcendental equations using Newton-Raphson Method and Generalized Newton's method	Discussion with Illustration	Quiz and Test
	5	Secant Method - Problems based on Secant Method and graphical representation, Muller's Method, Problems based on Muller's Method	3	To understand the methods of Secant and Muller's	Lecture	Test
II	**Interpolation**					
	1	Forward Differences, Backward Differences and Central Differences,	3	Understand the significance of the finite, forward, backward and central	Lecture	Test

		Problems related to Forward Differences, Backward Differences and Central Differences, Detection of Errors by use of difference tables		differences and their properties.		
	2	Differences of a polynomial, Newton's formulae for Interpolation, Problems based on Newton's formulae for Interpolation	3	To practice various problems	Lecture	Test
	3	Central Difference Interpolation formulae - Gauss's forward central difference formulae, Problems related to Gauss's forward central difference formulae, Problems related to Gauss's backward formula	3	To solve problems using Gauss's forward central and Gauss's backward formula	Lecture	Formative Assessment Test
	4	Stirling's formulae, Problems related to Stirling's formulae, Bessel's formulae	3	To solve problems using Stirling's formulae	Group Discussion	Test
	5	Problems related to Bessel's formulae, Everett's formulae, Problems related to Everett's formulae	3	To solve problems using Bessel's formulae and Everett's formulae	Group Discussion	Test
III	**Numerical Differentiation and Numerical Integration**					
	1	Numerical Differentiation formula using Newton's forward difference formulae, Numerical Differentiation formula using Newton's backward difference formulae, Numerical Differentiation formula using Stirling's formulae	3	To construct various Numerical Differentiation formulae	Lecture Illustration	Quiz
	2	Problems related to Numerical Differentiation, Errors in Numerical Differentiation	3	To solve problems related to Numerical Differentiation	Lecture with Illustration	Test
	3	Numerical Integration, Trapezoidal rule, Problems related to	3	To solve problems using Trapezoidal rule	Lecture	Test

		Trapezoidal rule				
	4	Simpson's 1/3 rule, Problems related to Simpson's 1/3 rule, Simpson's 3/8 rule	3	To identify the principles and solve problems	Group Discussion	Formative Assessment Test
	5	Problems related to Simpson's 3/8 rule, Boole's rule, Weddle's rule, Problems related to Boole's and Weddle's rule	4			
IV	**Numerical Linear Algebra**					
	1	Solution of Linear systems – Direct methods: Gauss elimination, Necessity for Pivoting, Problems related to Gauss elimination	3	To understand the Gauss elimination and practice problems based on it	Lecture with Illustration	Quiz
	2	Gauss-Jordan method, Problems based on Gauss-Jordan method, Modification of the Gauss method to compute the inverse	3	To understand Gauss-Jordan method	Lecture and group discussion	Test
	3	Examples to compute the inverse using Modification of the Gauss method, LU Decomposition method and related problems, Solution of Linear systems - Iterative methods	4	To compute the inverse using different methods	Lecture with Illustration	Test
	4	Gauss-Seidal method, Problems related to Gauss-Seidal method, Jacobi's method, Problems related to Jacobi's method	4	To understand the Gauss-Seidal method and Jacobi's method	Lecture with Illustration	Test
V	**Numerical Solution of Ordinary Differential Equations**					
	1	Solution by Taylor's series, Examples for solving Differential Equations using Taylor's series, Picard's method of successive approximations	4	To solve Differential Equations using different methods	Lecture with Illustration	Test
	2	Problems related to Picard's method, Euler's	4	To understand the methods Picard's and Euler's and	Lecture with	Formative Assessment

		method, Error Estimates for the Euler Method, Problems related to Euler's method		practice problems related to it.	Illustration	test
	3	Modified Euler's method, Problems related toModified Euler's method, Runge - Kutta methods - II order and III order	3	To solve problems using Modified Euler's method	Lecture with Illustration	Assignment
	4	Problems related to Runge - Kutta II order and III order, Problems related to Fourth-order Runge - Kutta methods	4	To solve problems using Fourth-order Runge - Kutta methods	Lecture with Illustration	Assignment

Course Instructor (Aided): Dr.V.Sujin Flower HOD(Aided) :Dr. V. M. Arul Flower Mary Course Instructor(S.F): Ms. V. G. Michael Florance HOD(S.F) :Ms. J. Anne Mary Leema

Semester : III

Name of the course : Algebra III **Major Core IX**

Course code : PM1731

Number of hours/ Week	Credits	Total number of hours	Marks
6	5	90	100

Objectives:

1. To learn in depth the concepts of Galois Theory, theory of modules and lattices.
2. To pursue research in pure Mathematics.

Course Outcomes

CO	Upon completion of this course the students will be able to :	PSO addressed	CL
CO- 1	Recall the definitions and basic concepts of field theory and lattice theory	PSO-2, PSO-3	U
CO- 2	Express the fundamental concepts of field theory,Galois theory and theory of modules	PSO-2, PSO-3	U
CO- 3	Demonstrate the use of Galois theory to compute Galois over the rationals and modules	PSO-2, PSO-3	U
CO- 4	Distinguish between free module , quotient modules and simple modules	PSO-5	Ap
CO- 5	Interpret distributivity and modularity and apply these concepts in Boolean Algebra	PSO- 4	E
CO- 6	Understand the theory of Frobenius Theorem ,four square theorem and Integral Quaternions	PSO-2, PSO-3	U
CO- 7	Develop the knowledge of lattices and establish new relationships in	PSO-3,	C

	Boolean Algebra	PSO-4 PSO-5	

Teaching Plan

Total contact hours: 75 (Including lectures, assignments and tests)

Unit	Module	Topics	Lecture hours	Learning outcome	Pedagogy	Assessment/ Evaluation
I	Galois Theory					
	1	Fixed Field - Definition, Theorems based on Fixed Field, Group of Automorphism	4	Recall the definitions and basic concepts of field theory and lattice theory, Express the fundamental concepts of field theory, Galois theory and theory of modules	Lecture with illustration	Evaluation through: Short Test Formative assessment I
	2	Theorems based on group of Automorphism, Finite Extension, Normal Extension	4	Express the fundamental concepts of field theory, Galois theory and theory of modules	Lecture with PPT illustration	
	3	Theorems based on Normal Extension, Galois Group, Theorems based on Galois Group	4	Recall the definitions and basic concepts of field theory and lattice theory, Express the fundamental concepts of field theory, Galois theory and theory of modules	Lecture with illustration	
	4	Galois Group over the rationals, Theorems based on Galois Group over the rationals, Problems based on Galois Group over the rationals	3	Express the fundamental concepts of field theory, Galois theory and theory of modules, Demonstrate the use of Galois theory to compute Galois Group over the rationals and modules	Lecture with illustration	
II	Finite Fields					
	1	Finite Fields – Definition, Lemma-Finite Fields, Corollary-Finite Fields	3	Recall the definitions and basic concepts of field theory and lattice theory, Express the fundamental concepts of field theory, Galois theory and theory of modules	Lecture with illustration	Short Test Formative assessment I, II
	2	Theorems based on Finite Fields	4	Recall the definitions and basic concepts of field theory and lattice theory, Express the fundamental concepts of field theory, Galois theory and theory	Lecture with PPT illustration	

				of modules		
	3	Theorems based on Finite Fields, Wedderburn's Theorem on finite division ring	4	Recall the definitions and basic concepts of field theory and lattice theory	Lecture with PPT illustration	
	4	Wedderburn's Theorem, Wedderburn's Theorem-First Proof	3	Recall the definitions and basic concepts of field theory and lattice theory, Express the fundamental concepts of field theory, Galois theory and theory of modules	Lecture with illustration	
III	**A Theorem of Frobenius**					
	1	A Theorem of Frobenius-efinitions, Algeraic over a field, Lemma based on Algeraic over a field	3	Understand the theory of Frobenius Theorem, four square theorem and Integral Quaternions	Lecture with illustration	Short Test Formative assessment II Assignment on lemma based on Algebraic
	2	Theorem of Frobenius, Integral Quaternions, Lemma based on Integral Quaternions	5	Recall the definitions and basic concepts of field theory and lattice theory, Understand the theory of Frobenius Theorem, four square theorem and Integral Quaternions	Lecture with illustration	
	3	Theorems based on Integral Quaternions, Lagrange Identity, Left division Algorithm	4	Understand the theory of Frobenius Theorem, four square theorem and Integral Quaternions	Lecture with illustration	
	4	Lemma based on four square Theorem, Theorems based on four square Theorem	4	Recall the definitions and basic concepts of field theory and lattice theory	Lecture with PPT illustration	
IV	**Modules**					
	1	Modules-Definitions, Direct Sums, Free Modules, Vector Spaces	4	Demonstrate the use of Galois theory to compute Galois over the rationals and modules, Distinguish between free module, quotient modules and simple modules	Lecture with PPT illustration	Short Test Formative assessment III
	2	Theorems based on Vector Spaces, Quotient Modules, Theorems based on	4	Distinguish between free module, quotient modules and simple modules	Lecture with illustration	

		Quotient Modules				
	3	Homomorphisms, Theorems based on Homomorphisms, Simple Modules	4	Demonstrate the use of Galois theory to compute Galois over the rationals and modules	Lecture with illustration	
	4	Theorems based on Simple Modules, Modules over PID's	3	Demonstrate the use of Galois theory to compute Galois over the rationals and modules	Lecture with illustration	
V	**Lattice Theory**					
	1	Partially ordered set-Definitions, Theorems based on Partially ordered set	3	Recall the definitions and basic concepts of field theory and lattice theory	Lecture with illustration	Short Test Formative assessment III Seminar on Lattice
	2	Totally ordered set, Lattice, Complete Lattice	4	Recall the definitions and basic concepts of field theory and lattice theory, Interpret distributivity and modularity and apply these concepts in Boolean Algebra, Develop the knowledge of lattice and establish new relationships in Boolean Algebra	Lecture with illustration	
	3	Theorems based on Complete lattice, Distributive Lattice	3	Interpret distributivity and modularity and apply these concepts in Boolean Algebra, Develop the knowledge of lattice and establish new relationships in Boolean Algebra	Lecture with illustration	
	4	Modular Lattice, Boolean Algebra, Boolean Ring	4	Develop the knowledge of lattice and establish new relationships in Boolean Algebra	Lecture with PPT illustration	

Course Instructor (Aided): Dr. L.Jesmalar HOD(Aided) :Dr. V. M. Arul Flower Mary Course Instructor(S.F): Dr. C. Jenila HOD(S.F) :Ms. J. Anne Mary Leema

Semester : III **Major Core X**
Name of the Course :Topology
Subject code : PM1732

No. of Hours per Week	Credits	Total No. of Hours	Marks
6	5	90	100

Objectives:

1. To distinguish spaces by means of simple topological invariants.

2. To lay the foundation for higher studies in Geometry and Algebraic Topology.

Course Outcomes

CO	Upon completion of this course the students will be able to :	PSO addressed	CL
CO- 1	Understand the definitions of topological space, closed sets, limit points, continuity, connectedness, compactness, separation axioms and countability axioms.	PSO-2, PSO-3	U
CO- 2	Construct a topology on a set so as to make it into a topological space	PSO-3, PSO-4, PSO-5	C
CO- 3	Distinguish the various topologies such as product and box topologies and topological spaces such as normal and regular spaces.	PSO-2, PSO-3	U, An
CO -4	Compare the concepts components and path components, connectedness and local connectedness, countability axioms.	PSO-2, PSO-3, PSO-4	E, An
CO- 5	Practice various Theorems related to regular space, normal space, Hausdorff space, compact space.	PSO-5	Ap
CO- 6	Construct continuous functions, homeomorphism, projection mapping.	PSO-3, PSO-4, PSO-5	C

Teaching Plan

Total contact hours: 75 (Including lectures, assignments and tests)

Unit	Section	Topics	Lecture hours	Learning outcomes	Pedagogy	Assessment/evaluation
I	**Topological space**					
	1	Definition of topology, discrete and indiscrete topology, finite complement topology, Basis for a topology and examples	3	To understand the definitions of topological space and different types of topology	Lecture with PPT	Test
	2	Comparison of standard and lower limit topologies, Order topology: Definition & Examples, Product topology: Definition & Theorem	4	To compare different types of topology and Construct a topology on a set so as to make it into a topological space	Lecture	Test
	3	Subspace topology: Definition & Examples, Theorems	3	To understand the definition of subspace topology with examples and theorems	Lecture	Test
	4	Closed sets: Definition	4	To understand the definitions	Lecture	Test

		& Examples, Theorems, Limit points: Definition Examples & Theorems		of closed sets and limit points with examples and theorems		
	5	Hausdorff Spaces: Definition & Theorems	2	To identify Hausdorff spaces and practice various theorems	Lecture	Test
II		**Continuous functions**				
	1	Continuity of a function: Definition, Examples, Theorems and Rules for constructing continuous function	3	To understand the definition of continuous functions and construct continuous functions	Lecture	Test
	2	Homeomorphism: Definition & Examples, Pasting lemma & Examples	3	To understand the definition of homeomorphism and prove theorems	Lecture	Formative Assessment Test
	3	Maps into products, Cartesian Product, Projection mapping	3	To practice various Theorems related to Maps into products, Cartesian Product, Projection mapping	Lecture	Test
	4	Comparison of box and product topologies, Theorems related to product topologies, continuous functions and examples	5	To distinguish the various topologies such as product and box topologies and topological spaces	Lecture	Test
III		**Connectedness and Compactness**				
	1	Definitions: connected space open and closed sets, lemma, examples, Theorems.	4	To understand the concepts of connected space open and closed sets	Group discussion	Quiz
	2	Product of connected spaces, examples, Components and local connectedness	3	To understand the concept product of connected spaces with examples	Lecture with illustration	Test
	3	Path components, Locally connected: Definitions, Theorems	3	To compare the concepts components and path components, connectedness and local connectedness	Lecture	Test
	4	Compact space: Definition, Examples, Lemma, Theorems and Image of a compact space	3	To understand the concept compact space with examples and theorems	Lecture and Seminar	Assignment
	5	Product of finitely many compact spaces, Tube lemma, Finite intersection property: Definition & Theorem	3	To practice various theorems related to product of finitely many compact spaces, Tube lemma, Finite intersection property	Lecture	Formative Assessment Test

IV	**Compactness, Countability and separation axioms**					
	1	Local compactness: Definition & Examples, Theorems	3	To understand the concept local compactness with examples and theorems	Lecture with illustration	Quiz
	2	One point compactification, First Countability axiom, Second Countability axiom: Definitions, Theorems,	3	To compare countability axioms	Lecture	Test
	3	Dense subset: Definitions & Theorem, Examples, Lindelof space : Definition , Examples	3	To understand the definition of dense subset and identify Lindelof space	Lecture and Seminar	Test
	4	Regular space & Normal space: Definitions, Lemma, Relation between the separation axioms,	3	To distinguish various topological spaces such as normal and regular spaces	Lecture	Test
	5	Examples based on separation axioms	2	To practice examples based on separation axioms	Group discussion	Test
V	**Countability and separation axioms**					
	1	Theorem based on separation axioms and Metrizable space	3	To practice various Theorems related to separation axioms and Metrizable space	Lecture with illustration	Quiz
	2	Compact Hausdorf space, Well ordered set	3	To understand the concept compact Hausdorf space, Well ordered set	Lecture	Test
	3	Urysohn lemma,	3	To constuct Urysohn lemma	Lecture	Formative Assessment Test
	4	Completely regular: Definition & Theorem	2	To understand the concept Completely regular space	Lecture	Assignment
	5	Tietze extension theorem	3	To constuct Tietze extension theorem	Lecture	Assignment

Course Instructor (Aided): Ms. T.Sheeba Helen HOD(Aided) :Dr. V. M. Arul Flower Mary Course Instructor(S.F): Ms. D. Berla Jeyanthy HOD(S.F) :Ms. J. Anne Mary Leema

Semester : III

Name of the Course : Measure Theory and Integration Major Core X

Subject Code : PM1733

Number of hours/ week	Credits	Total number of hours	Marks
6	4	90	100

Objectives:

1. To generalize the concept of integration using measures

2. To develop the concept of analysis in abstract situations.

Course Outcomes

CO No.	Upon completion of this course, the students will be able to	**POs addressed**	**CL**
CO- 1	Define the concept of measures and some properties of measures and functions, Vitali covering	PSO 1	R
CO- 2	Cite examples of measurable sets , functions , explain Riemann integrals, Lebesgue integrals	PSO-2, PSO-3	U
CO- 3	Apply measures and Lebesgue integrals in various measurable sets and measurable functions	PSO-5	Ap
CO- 4	Apply outer measure,differentiation and integration	PSO-5	Ap
CO- 5	Compare the different types of measures and Signed measures	PSO-2,PSO-3	An
CO- 6	Construct L^p spaces and outer measurable sets	PSO-3,PSO-4, PSO-5	C

Teaching Plan

Total contact hours: 75 (Including lectures, assignments and tests)

Unit	**Module**	**Topics**	**hours**	**Learning Outcome**	**Pedagogy**	**Assessment Evaluation**
I	1.	Lebesgue Measure - Introduction, outer measure	4	To understand the measure and outer measure of any interval	Lecture, Illustration	Evaluation through : Class test on outer measure and Lebesgue
	2.	Measurable sets and Lebesgue measure	5	To be able to prove Lebesgue measure using measurable sets	Lecture, Group discussion	

	3.	Measurable functions	4	To understand the measurable functions and its uses to prove various theorems	Lecture, Discussion	measure
	4.	Littlewood's three principles (no proof for first two).	2	To differentiate convergence and pointwise convergence	Lecture, Illustration	Quiz Formative assessment- I
II	1.	The Lebesgue integral - the Riemann Integral	1	To recall Riemann integral and its importance	Lecture, Discussion	Formative assessment- I
	2.	The Lebesgue integral of a bounded function over a set of finite measure	5	To understand the use of integration in measures	Lecture, Group discussion	Multiple choice questions Short test on the integral of a non-negative function
	3.	The integral of a non-negative function	5	To prove various theorems using non-negative functions	Lecture, Illustration	
	4.	The general Lebesgue integral	4	To understand a few named theorems and proofs	Lecture	Formative assessment-II
III	1.	Differentiation and integration-differentiation of monotone functions	4	To recall monotone functions and use them with differentiation and integration	Lecture, Group discussion	Multiple choice questions Unit test on functions of bounded variation
	2.	Functions of bounded variation	4	To evaluate the bounded variation of different functions	Lecture, Illustration	Formative assessment-II
	3.	Differentiation of an integral	4	To find differentiation of integrals	Lecture	
	4.	Absolute continuity	3	To differentiate continuity and absolute	Lecture, Illustration	

				continuity		
IV	1.	Measure and integration-Measure spaces	3	To understand concepts of measure spaces	Lecture, Group discussion	Formative assessment-II
	2.	Measurable functions	3	To recall measurable functions and use them in measure spaces	Lecture, Discussion	Seminar on measure spaces, measurable functions and integration
	3.	Integration	3	To integrate functions in measure spaces	Lecture, Illustration	
	4.	General convergence theorems	3	To learn various convergence theorems in measure spaces	Lecture, Discussion	Assignment - general convergence theorems and signed measures
	5.	Signed measures	3	To understand signed measures in detail	Lecture	Formative assessment-III
V	1.	The L^P spaces	5	To understand L^P spaces	Lecture, Illustration	Seminar on outer measure, measurability and extension theorem
	2.	Measure and outer measure-Outer measure and measurability	3	To understand outer measure and easurability in L^P spaces	Lecture, Discussion	Short test on outer measure and measurability
	3.	The extension theorem	7	To prove various theorems in L^P spaces	Lecture, Group discussion	Formative assessment-III

Course Instructor (Aided): Dr. V. M. Arul Flower Mary HOD(Aided) :Dr. V. M. Arul Flower Mary Course Instructor(S.F): Ms. V. Mara Narghese HOD(S.F) :Ms. J. Anne Mary Leema

Semester : **III**

Name of the Course : **Algebraic Number Theory** **Elective III**

Course Code : **PM1734**

No. of Hours per Week	Credits	Total No. of Hours	Marks
6	4	90	100

Teaching Plan

Unit	Module	Topics	Lecture hours	Learning Outcome	Pedagogy	Assessment/ Evaluation
I	**Quadratic reciprocity and Quadratic forms**					
	1	Quadratic Residues, definition, Legender symbol definition and Theorem based on Legender symbol	3	To understand quadratic and power series forms and Jacobi symbol	Lecture with Illustration	Test
	2	Lemma of Gauss, Definition, theorem based on Legender symbol	4	To understand quadratic and power series forms and Jacobi symbol and to detect units and primes in quadratic fields	Lecture with Illustration	Test
	3	Quadratic reciprocity, Theorem based on Quadratic reciprocity, The Jacobi symbol, definition	3	To understand quadratic and power series forms and Jacobi symbol	Lecture with PPT Illustration	Quiz and Test
	4	Theorems based on Jacobi symbol	2	To determine solutions of Diophantine equations	Lecture with Illustration	Formative Assessment Test
	5	Theorem based on Jacobi symbol and Legender symbol	2	To apply binary quadratic forms for the decomposition of a number into sum of sequences	Lecture with Illustration	Evaluation through test
II	**Binary Quadratic forms**					
	1	Introductio, definition and Theorems based on Quadratic forms	2	To recall the basic results of field theory and to apply binary quadratic forms for the decomposition of a number into sum of sequences	Lecture with PPT Illustration	Test
	2	Definition, theorems based on binary Quadratic forms	4	To understand quadratic and power series forms and Jacobi symbol and to detect units and primes in quadratic fields	Lecture with Illustration	Quiz and Test
	3	Definition, Theorems based on modular group, Definition, theorem based on perfect square	3	To understand quadratic and power series forms and Jacobi symbol and to detect units and primes in quadratic fields	Lecture with Illustration	Test
	4	Theorems based on	2	To calculate the possible	Lecture with	Test

		reduced Quadratic forms		partitions of a given number and draw Ferrer's graph	PPT Illustration	
	5	Sum of two squares ,Theorems based on sum of two squares	2	To apply binary quadratic forms for the decomposition of a number into sum of sequences	Lecture with Illustration	Quiz and Test
III	**Some Diophantine equation**					
	1	Introduction, The equation ax+by=c, Theorems based on ax+by=c	4	To recall the basic results of field theory and to understand quadratic and power series forms and Jacobi symbol	Lecture with Illustration	Formative Assessment Test
	2	Examples based on ax+by=c, Simultaneous linear equation,Example-3	3	To calculate the possible partitions of a given number and draw Ferrer's graph and to Identify formal power series and compare Euler's identity and Euler's formula	Lecture with PPT Illustration	Test
	3	Examples based on Simultaneous linear equation, Example-5	3	To calculate the possible partitions of a given number and draw Ferrer's graph	Group Discussion	Quiz and Test
	4	Theorem based on Simultaneous linear equation, Definition,Theorems based on integral solution	3	To understand quadratic and power series forms and Jacobi symbol and to detect units and primes in quadratic fields	Lecture with Illustration	Test
	5	Lemma, Theorems based on primitive solution	2	To detect units and primes in quadratic fields	Lecture with Illustration	Test
IV	**Algebraic Numbers**					
	1	Polynomials,Theorem based on Polynomials, Theorem based on irreducible Polynomials, Theorem based on primitive Polynomials	3	To understand quadratic and power series forms and Jacobi symbol and to detect units and primes in quadratic fields	Lecture with Illustration	Test
	2	Gauss lemma,Algebraic numbers definition, Theorem based on Algebraic numbers	4	To recall the basic results of field theory and to detect units and primes in quadratic fields	Lecture with PPT Illustration	Test
	3	Theorem based on Algebraic numbers, Algebraic integers, Algebraic number fields, Theorem based on Algebraic numbers fields, Theorem based on ring of polynomials	4	To apply binary quadratic forms for the decomposition of a number into sum of sequences to detect units and primes in quadratic fields	Lecture with Illustration	Test
	4	Algebraic integers Theorem based on	3	To understand quadratic and power series forms and Jacobi	Lecture with Illustration	Formative Assessment Test

		Algebraic integers, Quadratic fields , Theorem based on Quadratic fields , Definition, Theorem based on norm of a product		symbol and to determine solutions of Diophantine equations		
	5	Units in Quadratic fields Theorem based on Quadratic fields , Primes in Quadratic fields	3	To calculate the possible partitions of a given number and draw Ferrer's graph and to Identify formal power series and compare Euler's identity and Euler's formula	Lecture with PPT Illustration	Test
V	**The partition Function**					
	1	Partitions definitions,theorems based on Partitions	2	To understand quadratic and power series forms and Jacobi symbol	Lecture with Illustration	Test
	2	Ferrers Graphs,Theorems based on Ferrers Graphs	3	To identify formal power series and compare Euler's identity and Euler's formula	Lecture with Illustration	Quiz and Test
	3	Formal power series and identity, Euler formula	2	To apply binary quadratic forms for the decomposition of a number into sum of sequences	Lecture with Illustration	Formative Assessment Test
	4	Theorems based on Formal power series and identity, Euler formula	3	To detect units and primes in quadratic fields	Lecture with Illustration	Test
	5	Theorems based on absolute convergent	3	To understand quadratic and power series forms and Jacobi symbol	Lecture with Illustration	Test

Course Instructor (Aided): Ms.Jancy Vini HOD(Aided) :Dr. V. M. Arul Flower Mary Course Instructor(S.F): Ms. V. Princy Kala HOD(S.F) :Ms. J. Anne Mary Leema