Semester : II **Major Core V**

Name of the course : Modules and Vector Spaces

Course code : PM2021

Number of hours per week	Credits	Total number of hours	Marks
6	5	90	100

Objective:

To understand the concept of Modules and the advanced forms of Matrices related to Linear Transformations.

Course Outcome

CO	Upon completion of this course the students will be able to :	PSOs addressed	CL
CO - 1	recall the definitions and properties of Vector Spaces and Subspaces	PSO - 2	R
CO - 2	analyze the concepts Linear Independence, Dependence and Basis	PSO - 2	An
CO - 3	apply the definition and properties of Linear transformation and Matrices of Linear transformation	PSO - 3	Ap
CO - 4	gain knowledge about characteristic polynomial, eigen vectors, eigen values and eigen spaces as well as the geometric and the algebraic multiplicities of an eigen value	PSO - 1	U
CO - 5	learn and apply Jordan form and triangular form for computations	PSO - 4	U

Total contact hours: 90 (Including lectures, assignments and tests)

Unit	Section	Topics	Lecture hours	Learning outcome	Pedagogy	Assessment/ Evaluation
I	**Module**					
	1	Basic definitions and examples	4	Recall the definitions and basic concepts of fields and modules	Lecture with illustration	Evaluation through:

	2	Quotient modules and module homomorphism	4	Express the fundamental concepts of field theory, module theory and theory of quotient modules	Lecture with illustration	Unit Test Quiz
	3	Generation of Modules	4	Recall the definitions and basic concepts of module theory. Understand the theorems in modules.	Lecture	Formative assessment I
	4	Direct sums and Free Modules	3	Demonstrate the use of module theory to compute Direct sums and Free Modules.	Lecture with illustration	
II	**Vector Spaces**					
	1	Elementary basic concepts: Vector space, Subspace, Vector space homomorphism	3	Recall the definitions and basic concepts of Vector spaces and Subspaces.	Lecture with illustration	Unit Test Quiz
	2	Linear span, Finite dimensional vector space, Linearly dependent, Linearly independent	4	Learn the definition of Linear span and Finite dimensional vector space. Analyze the conceptslinearly dependent and inearly independent.	Lecture	Problem Solving
	3	Basis, dimension	4	Learn the concept of basis and dimension. Use the concept of basis and dimension in finite dimensional vector space	Lecture with illustration	Formative assessment I

	4	Dual Spaces	3	Understand the theorems in dual spaces.	Lecture	
III	**Linear Transformations**					
	1	Algebra of Linear Transformation, Regular, Singular, Range, Rank	3	Recall the definition of vector space homomorphism. Understand the concept of Regular, Singular, Range and Rank of Linear Transformations.	Lecture with illustration	Unit Test Quiz Problem Solving Online Assignment on range Formative assessment I, II
	2	Characteristic Root, Characteristic vector, Matrices	5	Gain knowledge about Characteristic root and Characteristic vector. Apply the definition and properties of Linear transformation and Matrices of Linear transformation	Lecture with illustration	
	3	Canonical Forms: Triangular Form, Similar, Invariant subspace	4	Learn and apply triangular form for computations	Lecture	
	4	Canonical Forms: Nilpotent Transformation, Index of nilpotence	4	Recall the definitions and basic concepts of Linear Transformations. Understand the theorems in nilpotent Linear Transformations.	Lecture	
IV	**Canonical Forms**					

	1	Jordan form	4	Learn and apply Jordan form for computations.	Lecture	Unit Test Class Test Quiz Seminar on Canonical Forms Formative assessment II
	2	Rational Canonical Form, Companion matrix, Elementary divisor, Characteristic polynomial	4	Gain knowledge about Companion matrix, Elementary divisor and Characteristic polynomial.	Lecture	
	3	Trace	4	Understand the properties of trace and Jacobson Lemma.	Lecture	
	4	Transpose, Symmetric matrix, Adjoint	3	Understand the properties of Transpose, Symmetric matrix and Adjoint.	Lecture	
V	**Determinants and Quadratic forms**					
	1	Determinants, Secular equation	3	Find determinant of a triangular matrix. Understand Cramer's Rule.	Lecture with illustration	Unit Test Quiz Problem Solving
	2	Hermitian, Unitary	4	Recall the properties of real and complex numbers and apply these concepts in Linear transformation. Develop the knowledge of Hermitian and Unitary Linear transformation.	Lecture with illustration	

	3	Normal Transformation	3	Recall the properties of real and complex numbers and apply these concepts in Normal transformation.	Lecture	Seminar on Quadratic forms
	4	Real Quadratic forms, Congruent	4	Learn and apply Quadratic form for computations.	Lecture	Formative assessment II

Course Instructor(Aided): Dr.T.Sheeba Helen HOD(Aided) :Dr.V.M.Arul Flower Mary

Course Instructor(S.F): Dr.C.Jenila HOD(S.F) :Mrs.J. Anne Mary Leema

Semester : II **Major Core VI**

Name of the Course : Analysis II

Subject code : PM2022

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

Objectives: 1. To make the students understand the advanced concepts of Analysis.

2. To pursue research in Analysis related subjects.

Course Outcome

CO	Upon completion of this course the students will be able to :	PSOs addressed	CL

CO -1	recall the definition of continuity, boundedness and some results on uniform convergence	PSO-1	R
CO -2	recognise the difference between pointwise and uniform convergence of a sequence of functions and Riemann Stieltjes integrals.	PSO-2	An
CO -3	understand the close relation between equicontinuity and uniform convergence of sequence of continuous function and rectifiable curves	PSO-3	U
CO -4	learnParseval's theorem, Stone Weierstrass theorem and know about its physical significance in terms of the power of the Fourier components.	PSO-4	U
CO -5	utilize the definition of differentiation and partial derivative of function of several variables to solve problems	PSO-3	Ap

Total contact hours: 90 (Including lectures, assignments and tests)

Unit	**Section**	**Topics**	**Lecture hours**	**Learning outcomes**	**Pedagogy**	**Assessment/ evaluation**
I	**Riemann Stieltjes Integral**					
	1	Definition and existence of Riemann Stieltjes integrals	3	To understand the definition existence of Riemann Stieltjes integrals	Lecture with Illustration	Evaluation through test
	2	Theorems related to Riemann Stieltjes integrals	3	To understand the theorems related to Riemann Stieltjes integrals	Lecture	Short Test
	3	Properties of Riemann Stieltjes integrals	3	To understand the properties of Riemann Stieltjes integrals	Lecture with Illustration	Slip Test

	4	Fundamental theorem of Calculus and related problems	3	To understand and apply this theorem in various problems	Lecture with Illustration	Quiz
	5	Rectifiable curves and problems	3	To understand rectifiable curves and able to do the problems related to it.	Lecture with Illustration	Formative Assessment Test
II	**Sequences and series of functions**					
	1	Definition and examples of convergence sequence	3	Recall the definition understand the examples of convergence sequence	Lecture with Illustration	Test
	2	Definition and theorems based on uniform convergence and continuity	5	To distinguish between convergence and uniform convergence	Lecture	Open book assignment
	3	Theorems based on uniform convergence and differentiation	4	To understand the relation between the uniform convergence and differentiation	Lecture	Q&A
	4	Problems based on sequences and series of functions	4	To analyze and solve the problems	Group Discussion	Formative Assessment Test
III	**Equicontinuous families of function**					
	1	Definition and theorems based on equicontinuous families of functions	5	To understand the definition and theorems based on equicontinuous families of functions	Lecture with Illustration	Quiz
	2	Definition of uniformly closed algebra and uniformly closure	4	To understand the concept of uniformly closed algebra in various theorems	Lecture with Illustration	Slip Test

	3	Stone Weierstrass theorem	2	To learn Stone Weierstrass theorem	Lecture	Test
	4	Problems on equicontinuous families of functions	3	To apply the concept of equicontinuousand solve problems	Group Discussion	Brain Stroming
IV	**Some special functions**					
	1	Definition, Theorems and examples of analytic function and power series	4	To learn the concept of power series	Lecture with Illustration	Quiz
	2	The algebraic completeness of the complex field	3	To get the idea of algebraic completeness of the complex field	Lecture and group discussion	Test
	3	Definition and theorems related to Fourier Series	3	To learn the definition and theorems related to Fourier Series	Lecture with Illustration	Quiz and Test
	4	Problems related to Fourier Series and Dirichlet Kernel	2	To understand the significance of Fourier series and apply it in problems	Lecture with Illustration	Formative Assessment Test
	5	Localisation Theorem and Parseval's theorem	2	To learn the concept of trigonometric series	Lecture	Short Test
V	**Differentiation**					
	1	Introduction of differentiation , Definition of total and partial derivative and examples	4	To identify total derivative problems	Lecture with Illustration	Quiz
	2	Theorems and examples based on Partial derivatives	4	To apply the concept of Partial derivatives	Lecture with Illustration	Short Test

	3	Definition of continuously differentiable and related theorems	3	To utilize the concept of continuously differentiable	Lecture with Illustration	Open Book Assignment
	4	Contraction principle and related theorems	2	To interpret the concept of contraction principle	Lecture with Illustration	Assignment
	5	The inverse function theorem and problems	3	To develop the proof technique and solve problems.	Lecture with Illustration	Formative Assessment Test

Course Instructor(Aided): Dr. K. Jeya Daisy HOD(Aided) :Dr. V. M. Arul Flower Mary

Course Instructor(S.F): Ms. C.JoselinJenisha HOD(S.F) :Ms.J. Anne Mary Leema

Semester : II Major Core VII

Name of the Course : Partial Differential Equations

Course Code : PM2023

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

Objectives:

1. To formulate and solve different forms of partial differential equations.
2. Solve the related application oriented problems.

Course Outcome

CO	Upon completion of this course the student will be able to:	PSOs addressed	CL
CO-1	recall the definitions of complete integral, particular integral and singular integrals.	PSO-2	R
CO-2	learn some methods to solve the problems of non- linear first order partial differential equations. homogeneous and non homogeneous linear partial differential equations with constant coefficients and solve related problems.	PSO-1	U

CO-3	analyze the classification of partial differential equations in three independent variables – cauchy's problem for a second order partial differential equations.	PSO-3	An
CO-4	solve the boundary value problem for the heat equations and the wave equation.	PSO-4	Ap
CO-5	apply the concepts and methods in physical processes like heat transfer and electrostatics.	PSO-5	Ap

Total contact hours: 90 (Including lectures, assignments and tests)

Unit	Section	Topics	Lecture hours	Learning outcomes	Pedagogy	Assessment/ evaluation
I	**Non -linear partial differential equations of first order**					
	1	Explanation of terms, compactible system of first order equations, Examples related to compactible system	3	To Recall the definitions of complete integral, particular integral and singular integral	Lecture	Quiz
	2	Charpit's Method and problems, Problems related to charpit's method	4	ToAnalyzeCharpit's Method and to solve the problems.	Lecture	Assignment
	3	Problems related to charpit's method	2	To Learn Charpit's Method methods to solve the problems	Lecture	Test
	4	Solving problems using charpit's method	3	To Learn Charpit's Method methods to solve the problems	Lecture with group discussion	Test
	5	Problems related to charpit's method	3	To Learn Charpit's Method methods to solve the problems	Lecture	Assignment
II	**Homogeneous linear partial differential equation with constant coefficient**					
	1	Homogeneous and non- homogeneous linear equation with constant coefficient,	2	To Analyze homogeneous linear partial differential	Lecture	Test

		Solution of finding homogeneous equation with constant coefficient, Theorem I, II		equations with constant coefficients		
	2	Method of finding complementary function, Working rule for finding complementary function, Alternative working rule for finding complementary function	2	To Learn some methods to solve the problems of homogeneous linear partial differential equations with constant coefficients	Lecture	Test
	3	Some examples for finding Complementary function	3	To find Complementary function	Lecture	Test
	4	General method and working rule for finding the particular integral of homogeneous equation and some example	3	To find particular integral of homogeneous equation	Lecture	Test
	5	Examples to find the particular integral	3	To find particular integral	Lecture	Test
III	**Non – homogeneous linear partial differential equations with constant coefficient**					
	1	Definition, Reducible and irreducible linear differential operators, Reducible and irreducible linear partial differential equations with constant coefficient, Determination of	2	Analyze non-homogeneous linear partial differential equations with constant coefficients and to solve the problems	Lecture with group discussion	Quiz

		complementary function				
	2	General solution and particular integral of non-homogeneous equation and some examples of type 1	3	To solve problems related to non-homogeneous equations of type 1	Lecture	Assignment
	3	Some examples of type 2	3	To solve problems related to non-homogeneous equations of type 2	Lecture	Assignment
	4	Some problems related to type 3	3	To solve problems related to non-homogeneous equations of type 3	Lecture	Formative Assessment
	5	Examples related to type 4, Miscellaneous examples for the determination of particular integral	4	To solve problems related to non-homogeneous equations of type 4	Lecture	Assignment
IV	**Classification of P.D.E. Reduction to Canonical (or normal) forms.**					
	1	Classification of Partial Differential equations of second order - Classification of P.D.E. in three independent variables	2	To classify Partial Differential equations of second order & of P.D.E. in three independent variables	Lecture	Test
	2	Cauchy's problem for a second order P.D.E. Characteristic equation and Characteristic curves of the second order P.D.E.	2	To solveCauchy's problem for a second order P.D.E.	Lecture	Test
	3	Laplace transformation. Reduction to	4	To reduce hyperbolic equation to its Canonical forms.	Lecture	Assignment

		Canonical (or normal) forms.(Hyperbolic type)				
	4	Laplace transformation. Reduction to Canonical (or normal) forms.(Parabolic type)	4	To reduce Parabolic equation to its Canonical forms.	Lecture	Test
	5	Laplace transformation. Reduction to Canonical (or normal) forms.(Elliptic type)	3	To reduce elliptic equation to its Canonical forms.	Lecture	Test
V	**Boundary Value Problem**					
	1	A Boundary value problem, Solution by Separation of variables, Solution of one dimensional wave equation, D'Alembert's solution, Solution of two dimensional wave equation	3	To Solve the boundary value problems for the wave equations	Lecture	Quiz
	2	Vibration of a circular membrane, Examples related to vibration of a circular membrane	4	To Solve the boundary value problems related to vibration of a circular membrane	Lecture	Test
	3	Solution of one dimensional heat equation, Problems related to solution of one dimensional heat equation	4	To Solve the boundary value problems for the heat equations	Lecture	Formative Assessment

	4	Solution of two dimensional Laplace's equation	3	To find the Solution of two dimensional Laplace's equation	Lecture	Test
	5	Solution of two dimensional heat equation	3	To Apply the concepts and methods in physical processes like heat transfer and electrostatics	Lecture	Assignment

Course Instructor(Aided): Ms.J.C.Mahizha HOD(Aided) :Dr. V. M. Arul Flower Mary

Course Instructor(S.F): Ms. V. Princy Kala HOD(S.F) :Ms. J. Anne Mary Leema

Semester : II **Major Core VIII**

Name of the Course : Graph Theory

Course Code : PM2024

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

Objectives:

1. To introduce the important notions of graph theory.

2. Develop the skill of solving application oriented problems.

Course Outcome

CO	Upon completion of this course the students will be able to :	PSO addressed	CL
CO - 1	identify cut vertices and understand various versions of connectedness of a graph.	PSO-1	An
CO - 2	understand the concept of Digraphs and characterize Eulerian Digraphs.	PSO-4	U,C
CO - 3	recall the definitions of Matchings and design proof for characterization of graphs containing a 1-factor.	PSO-1	R

CO - 4	solve problems involving coloring and learn necessary conditions for planar graphs.	PSO-2,3	Ap
CO - 5	learn the basic definitions of domination and review the concept of distance in a graph.	PSO-4	U

Total contact hours: 90 (Including lectures, assignments and tests)

Unit	Section	Topics	Lecture hours	Learning outcomes	Pedagogy	Assessment/ evaluation
I	**Connectivity**					
	1	Cut vertices - Definitions and Examples, Theorems based on Cut vertices, Theorems based on Cut vertices	4	Recall the basic definitions and fundamental concepts of graph theory	Lecture with illustration	Test
	2	Blocks - Definition and Example, Theorem based on nonseparable, Properties of blocks in a nontrivial connected graph, Connectivity - Definitions and Examples	3	Identify blocks and understand various versions of connectedness of a graph	Lecture	Test
	3	Hassler Whitney's Theorem, Theorems based on Connectivity, Connectivity and edge-connectivity number for the cubic graph	4	Solve problems involving connectivity	Lecture with Group Discussion	Test
	4	Harary graphs, Theorems based on Harary graphs,	4	Understand the concept of Harary graphs and Geodetic Sets.	Lecture	Test

		Geodetic Sets - Definitions and Examples, Theorem based on Geodetic Sets				
II	**Digraphs**					
	1	Strong Digraphs - Definitions and Examples, The First Theorem of Digraph Theory, Theorems related to Digraphs	3	To understand the definition of Strong Digraphs and prove theorems related to Digraphs	Lecture	Test
	2	Theorems related to Eulerian, Theorem related to Strong orientation	3	To prove theorems related to Eulerian and Strong orientation	Lecture	Formative Assessment Test
	3	Tournaments - Definitions and Examples, Theorem related to Tournaments	3	To practice various Theorems related to Tournaments	Lecture	Test
	4	Theorem based on Tournament and Hamiltonian path, Theorem based on strong tournament	3	Understand the concept of Hamiltonian path, and strong tournament	Lecture	Test
III	**Matchings and Factorization**					
	1	Matchings - Definitions and Examples, Theorem related to matching, Theorem related to system of distinct representatives	3	Identify Matchingsand prove theorems	Lecture	Quiz

	2	The Marriage Theorem, Theorem based on perfect matching, Gallai identities	3	To practice various Theorems	Lecture with illustration	Test
	3	Factorization - Definitions and Examples, Tutte's Theorem, Petersen's Theorem	3	To understand the concept Factorization with examples and theorems	Lecture with group discussion	Test
	4	Theorem based on 1- factor, Theorem based on 2-factorable, Hamiltonian Factorization, Theorem based on Hamiltonian Factorization	3	To compare the concepts 1- factor and 2-factorable, Hamiltonian and Factorization	Lecture	Assignment
	5	Theorem based on Kirkman triple system, Theorem based on Hamiltonian cycles and 1-factor, Decompositions and Graceful Labelings- Definitions and examples, Theorems related to Graceful labeling	3	To understand the definitions of Hamiltonian cycles, Decompositions and Graceful Labelings.		Formative Assessment Test
IV	**Planarity and Coloring**					
	1	Planar Graphs Planar Graphs - Definitions and Examples, The Euler Identity, Consequence of Euler Identity,	3	Cite examples of planar and nonplanar graphs	Lecture with illustration	Quiz

		Theorems related to Planar Graphs				
	2	Necessary condition for a graph to be planar, Kuratowski's Theorem, Vertex Coloring - Definitions and Examples, The Four Color Theorem	3	Learn necessary conditions for planar graphs	Lecture	Test
	3	Theorems and Examples related to chromatic number, An upper bound for the chromatic number of a graph in terms of its maximum degree, Brook's Theorem, Theorem based on triangle - free graph	3	To practice various Theorems	Lecture	Test
	4	Theorem based on triangle - free graph, Edge Coloring- Definitions and Examples, Vizing's Theorem, Theorems related to edge chromatic number	3	Understand the concept of Edge Coloring and edge chromatic number	Lecture	Test
	5	The Five Color Theorem, The Heawood Map Coloring Theorem and it's corollary	3	To practice various Theorems	Lecture with group discussion	Test
V	**Distance and Domination**					

	1	Distance - The center of a graph, Definitions and examples	3	To identify the center of a graph	Lecture	Assignment
	2	Theorems based on center of a graph, Distant Vertices, Periphery of the graph.	3	To practice various Theorems	Lecture with illustration	Assignment
	3	Theorems based on eccentricity, Theorems based on boundary vertex .Definition of interior vertex and related theorem .	3	To practice various Theorems	Lecture	Test
	4	The domination number of a graph- Definitions and Examples. Theorems related to domination number of a graph. Bounds for domination number.	3	To understand the concepts of domination and to practice various theorems	Lecture with illustration	Assignment
	5	Stratification. Definition of stratified graph. Definition of F domination number and F coloring. Theorems related to Fdomination number and F coloring	3	To understand the facts of Stratification and to practice various Theorems	Lecture with group discussion	Assignment

Course Instructor(Aided): Dr.V.Sujin Flower HOD(Aided) :Dr. V. M. Arul Flower Mary

Course Instructor(S.F): Dr.J.C.Eveline HOD(S.F) :Ms. J. Anne Mary Leema

Semester **: II** **Elective II**

Name of the Course **: Classical Dynamics**

Course Code **: PM2025**

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

Objectives:

1. To gain deep insight into concepts of Dynamics.

2. To do significant contemporary research.

Course Outcome

CO	Uponcompletion ofthiscoursethestudents Willbeableto:	PSO addressed	CL
CO–1	recall the concepts of Newton's laws of motion, momentum, acceleration, motion of a particle.	PSO-4	R
CO–2	understanding the generalized co-ordinates of the Mechanical system.	PSO-1	U
CO–3	apply D'Alembert's Principle to solve the problems involving System of particles.	PSO-2	Ap
CO-4	Solve the Newton's equations for simple configuration using Various methods.	PSO-1	C
CO-5	transforming the Lagrangian equations to Hamiltonian equations.	PSO-2	U
CO-6	define the canonical transformations and Lagrange and Poisson brackets.	PSO-4	R

Total contact hours: 90 (Including lectures, assignments and tests)

Unit	Section	Topics	Lecture hours	Learning outcome	Pedagogy	Assessment/ Evaluation
I	**The Mechanical System**					
	1	Introduction on the Mechanical System, equations	3	Understanding the generalized co-ordinates,	Lecture	Short Test

		of motion, generalized coordinates , degrees of freedom, configuration space		degrees of freedom, configuration space of the Mechanical system.		
	2	Holonomic constraints, Nonholonomic constraints, Unilateral constraints and examples	3	To define Holonomic constraints, Nonholonomic constraints, Unilateral constraints with illustration	Lecture and group discussion	Test
	3	Virtual displacement and virtual work, Principle of virtual work, D' Alembert's Principle,	3	To identify virtual displacement and virtual work, Principle of virtual work, D' Alembert's Principle,	Lecture	Test
	4	Generalized force and examples, Potential energy, work and kinetic energy, Conservation of energy	3	Define Generalized force with examples, Potential energy, work and kinetic energy, Conservation of energy	Lecture	Test
	5	Equilibrium and stability, angular momentum, generalized momentum and examples.	3	To study generalized momentum, angular momentum and examples.	Lecture	Test

II	**Derivation of Lagrange's equations**					
	1	Problems using Lagrange's equation, Form of the equations of motion, Nonholonomic systems.	3	To solve problems using Lagrange's equation, Form of the equations of motion and Non holonomic systems.	Lecture	Test
	2	Spherical pendulum, Double pendulum, Lagrange Multiplier and constraint forces	3	To define Spherical pendulum, Double pendulum, Lagrange Multiplier and constraint forces	Lecture and discussion	Test
	3	Particle in whirling tube, A particle with moving support,	3	To understand particle in whirling tube, and the particle with moving support,	Lecture	Formative Assessment
	4	Rheonomic constrained system, Ignorable coordinates, Example based on the Kepler Problem	3	To define rheonomic constrained system, Ignorable coordinates and example based on the Kepler Problem	Lecture	Test
	5	Routhian Function, Conservative systems, Natural systems, Liouville'ssystem	3	To understand Routhian Function, Conservative systems, Natural systems	Lecture	Test

				and Liouville's system		
III	**Hamilton's Principle**					
	1	Stationary values of afunction, Constrained Stationary values, Stationary value of a definite integral.	3	To define stationary values of a function, Constrained Stationary values and stationary value of a definite integral.	Lecture and discussion	Test
	2	Solving The Brachistochrone problem and Geodesic path Case of n independent variables	3	To solve the Brachistochrone problem and Geodesic path Case of n independent variables	Lecture	Test
	3	Multiplier Rule, Derivation of Hamilton's Equations The form of the Hamiltonian function	3	To understand Multiplier Rule, and Derivation of Hamilton's Equations and the form of the Hamiltonian function	Lecture and discussion	Test
	4	Legendre transformation The form of the Hamiltonian function Problems based on Hamilton's Equations	3	To evaluate the form of the Hamiltonian function Problems based on Hamilton's Equations	Lecture	Test
	5	Modified Hamilton's Principle Principle	3	To understand Modified Hamilton's	Lecture	Formative Assessment

		of least action, Problems based on other Variational Principles		Principle ,Principle of least action and Problems based on other Variational Principles		
IV	**Hamilton's Principal function**					
	1	Introduction on Hamilton's Principal function The canonical integral Pfaffian differential forms	3	To understand the foundation of Hamilton's Principle and differential forms.	Lecture	Test
	2	The Hamilton - Jacobi equation, Illustration of the Hamilton- Jacobi equation	3	To understand The Hamilton - Jacobi equationwith Illustration	Lecture	Test
	3	Any complete solution of the Hamilton - Jacobi equation leads to a solution of the Hamilton Problem	3	Evaluating any complete solution of the Hamilton - Jacobi equation	Lecture	Test
	4	Kepler's Problem. Jacobi's theorem, Conservative systems	3	To learn Kepler's Problem. Jacobi's theorem and Conservative systems	Lecture	Test
	5	Ignorable coordinates, Modified Hamilton - Jacobi equation Examples on	3	To understand Ignorable coordinates, Modified Hamilton - Jacobi equation with Examples	Lecture and discussion	Test

		Ignorable coordinates				
V	**Canonical Transformations**					
	1	Introduction to Differential forms and generating functions, Canonical Transformations Principle form of generating functions	3	To understand Differential forms generating functions, Canonical Transformations and Principle form of generating functions	Lecture	Test
	2	Further comments on the Hamilton-Jacobi method, Examples on Canonical Transformations, Some simple transformations	3	To identify the Hamilton-Jacobi method with Examples on Canonical Transformations and some simple transformations	Lecture	Test
	3	Homogenous canonical transformations, Point transformations, Momentum transformations	3	To understand Homogenous canonical transformations, Point transformations, Momentum transformations	Lecture	Test
	4	. Examples based on Special transformations,	3	To identify examples based on Special transformations	Lecture	Test
	5	Introduction to Lagrange and Poisson brackets, Problems based on	3	To understand Lagrange and Poisson brackets,	Lecture	Formative Assessment

		Lagrange and Poisson brackets, The bilinear Covariant		Problems based on Lagrange and Poisson brackets and the bilinear Covariant		

Course Instructor(Aided): Ms. J. Befija Minnie 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 : IV Major Core XIII

Name of the Course : Functional Analysis

Course code : PM2042

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

Objectives: 1. To study the three structure theorems of Functional Analysis and to introduce Hilbert Spaces and Operator theory

2. To enable the students to pursue research.

Course Outcome

CO	Upon completion of this course thestudents will be able to :	PSOs addressed	CL
CO – 1	learn and understand the definition of linear space , normed linear space, Banach Space and their examples	PSO - 1	R
CO – 2	explain the concept of different properties of Banach Spaces, Hahn Banach theorem	PSO -2	U
CO – 3	compare different types of operators and their properties, Natural imbedding	PSO - 2	Ap
CO – 4	explain the ideas needed for open mapping theorem , Open Mapping theorem	PSO - 1	C
CO – 5	construct the idea of projections , the spectrum of an operator and develop problem solving skills , Matrices, Determinants	PSO - 1	Ap

Total contact hours:90 (Including lectures, assignments and tests)

Unit	Section	Topics	Lecture hours	Learning outcomes	Pedagogy	Assessment/ evaluation
I	**Banach Spaces**					
	1.	Definition and, examples of a normed linear space and a Banach Space, Small preliminary results and theorem on Normed linear space.	3	To understand the concept of normed linear space and Banach space	Lecture	Question and Answer

	2.	Properties of a Closed unit sphere, Holder's Inequality and Minkowski's Inequality.	3	To understand the Properties of a Closed unit sphere and Holder's Inequality, Minkowski's Inequality	Lecture with illustrations	Group Discussion
	3.	Equivalent conditions theorem on continuous linear transformations, $B(N,N^1)$is a Banach space, Functionals and it's properties.	4	To understand the concept of Functionals and it's properties and Equivalent conditions theorem on continuous linear transformations	Lecture	Test
	4.	Definition of an Operator and small results on operators, Side result of Hahn Banach theorem and Hahn Banach theorem, Theorem based on functional in N*, Problems based on Normed linear spaces	5	To understand the concept of an Operator and Hahn Banach theorem	Lecture with illustration	Test and Assignment
II	**Conjugate space**					
	1.	Definitions of second conjugate space, induced functional, weak topology, weak* topology, Strong topology,	4	To understand the definition of conjugate space, weak* topology, strong topology.	Lecture	Test
	2.	Theorem on isometric isomorphism of Open mapping theorem and Open mapping theorem	4	To apply the definition and Lemma to prove the Open mapping theorem theorem.	Lecture	Q&A
	3.	Definition of Projection and Theorem on Projection, Closed Graph Theorem,	4	To understand the concepts of Projection and to practice theorems related to this concepts.	Lecture with illustration.	Formative Assessment Test
	4.	The conjugate of an operator , the Uniform , Boundedness theorem and theorem on	3	Applying theorem on conjugate of an operator	Lecture	Assignment

		isometric isomorphism				
III	**Hilbert Space**					
	1.	Definition and examples, Properties of a Hilbert Space, Schwarz Inequality, Parallelogram law Theorem on Convex subset of a Hilbert Space	3	To understand the Definition of a Hilbert Space and Schwarz Inequality, Parallelogram law, Theorem on Convex subset of a Hilbert Space	Lecture with illustration	Quiz
	2.	Theorem on Orthogonal Complements and theorem on closed linear subspaces	3	To apply the laws to prove the theorem	Lecture with illustration	Test
	3.	Definition and examples of orthonormal set and Bessel's Inequality, Theorems on Orthonormal Sets	5	To understand the definition and examples of orthonormal set and apply the Bessel's Inequality on Theorems	Lecture with group discussion	Brain storming
	4.	Gram –Schmidt Orthogonalization Process Theorem on Conjugate Space H*	4	To understand the concept of Schmidt Orthogonalization Process	Lecture with illustration	Assignment, Test
IV	**Adjoint operator**					
	1.	Definition and small results, Theorem on the properties of an adjoint operator	3	Acquire the knowledge about properties of an adjoint operator	Lecture with illustration	Quiz, Group discussion
	2.	Theorem-The set of all self adjoint operators is a real Banach space, Theorems on self adjoint operators	3	Applying theorems on self adjoint operators	Lecture	Q&A
	3.	Properties on Normal and Unitary Operators , Theorems on Normal and Unitary Operators,	3	Acquire the knowledge about Normal and Unitary Operators	Lecture	Slip Test
	4.	Projections- Definition and preliminaries,	3	To understand the definition and examples of projections and apply	Lecture with illustration	Brain Storming

		Theorems on Projections and Theorems on invariant subspace		the concept of invariant subspace on theorems		
	5.	Spectral theory, Definition of Spectrum of an operator and spectral theorem	3	To understand the concept of spectral theory and spectral theorem.	Lecture	Formative Assessment Test
V	**General Preliminaries on Banach Algebras**					
	1.	The definition and some examples of Banach algebra	3	To understand the definition and examples of Banach algebra	Lecture with illustration	Quiz
	2.	Theorems on Regular and Singular elements	4	To understand the regular and singular elements on Theorems	Lecture with illustration	Test
	3.	The definition and theorems on spectrum	4	To know the definition and theorems on spectrum	Lecture	Slip Test, Quiz
	4.	The formula and Theorems on Spectral radius	4	To understand the definition and theorems on Spectral radius	Lecture with illustration	Assignment

Course Instructor(Aided): Dr. V. M. Arul Flower Mary HOD(Aided) :Dr. V. M. Arul Flower Mary

Course Instructor(S.F): Dr. S.Kavitha HOD(S.F) :Ms. J. Anne Mary Leema

Semester : **IV** **Major Core XIV**

Name of the course : Operations Research

Course code : **PM2043**

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

Objectives: 1. To learn optimizing objective functions.

2. To solve life oriented decision making problems.

Course Outcome

CO	Upon completion of this course thestudents will be able to :	PSO addressed	CL
CO - 1	explain the fundamental concept of DP model , Inventory model and Queuing model	PSO - 2	U
CO - 2	relate the concepts of Arrow (Network)diagram representations, in critical path calculations and construction of the Time chart	PSO - 3	U
CO - 3	distinguish deterministic model and single item	PSO - 3	E
CO - 4	interpret Poisson and Exponential distributions and apply these concepts in Queuing models	PSO - 4	Ap
CO - 5	solve life oriented decision making problems by optimizing the objective function	PSO - 1	C

Total contact hours: 90 (Including lectures, seminar and tests)

Unit	Section	Topics	Lecture hours	Learning outcome	Pedagogy	Assessment/ Evaluation
I	**Elements of DP model**					
	1	Elements of the DP Model, The Capital Budgeting Example	4	Recall the definitions and basic concepts of linear programming.	Lecture with illustration	Short Test Formative assessment I
	2	More on the definition of the state	3	Express the fundamental	Lecture with illustration	

				concepts of dynamic programming		
	3	Examples of DP models and computation	3	Understand the significance and application of Reliability problem and compute it	Lecture discussion	Test
	4	Solution of linear programming by dynamic programming	2	Formulate and solve LPP by dynamic programming	Lecture with illustration	
	5	Game theory	3	Express the fundamental concepts of Game theory	Lecture discussion	Assignment
II	**Arrow (Network) Diagram**					
	1	Introduction Arrow (Network) ,Diagram Representations	3	Recall the definitions and basic concepts Arrow (Network) ,Diagram Representations	Lecture with illustration	Short Test Formative assessment I,
	2	Critical Path Calculations, Problem based on critical Path Calculations, Determination of floats	4	Understand the significance and application of Critical Path Calculations, Problem based on critical Path Calculations, Determination of floats	Lecture with PPT illustration	Seminar on Arrow (Network) Diagram Quiz
	3	Construction of the Time Chart	4	Understand the construction of the	Lecture with PPT illustration	

		and Resource Leveling, Problems based on Time Chart and Resource Leveling		Time Chart and Resource Leveling, Problems based on Time Chart		
	4	Probability and Cost Considerations in Project Scheduling .	2	Understand the properties of Probability and Cost Considerations in Project Scheduling	Lecture with discussion	
III	**Generalized Inventory model**					
	1	Introduction, Generalised Inventory model, Types of Inventory Models	4	Understand the theory of Inventory model	Lecture with illustration	Short Test Formative assessment II
	2	Deterministic Models, Single Item Static Model, Problems based on Single Item Static Model	4	Understand the significance and application of Single Item Static Model	Lecture with illustration	Seminar on Generalised Inventory model
	3	Single Item Static ,Model with Price Breaks, Problems based on Single Item Static Model	3	Understand the theory of Single Item Static Model with Price Breaks	Lecture with illustration	

		with Price Breaks				
	4	Multiple - Item static Model with Storage Limitations, Problems based on Multiple - Item static Model with Storage Limitations	2	Understand the theory of Multiple - Item static Model with Storage Limitations	Lecture with PPT illustration	
	5	Single – Item static Model with Storage Limitations.	2	Understand the theory of Single – Item static Model with Storage Limitations and apply it in problems	Lecture with discussion	
IV	**Queuing Model**					
	1	Basic Elements of the Queuing Model, Roles of Poisson Distributions, Roles of Exponential Distributions	3	Understand the theory of Queuing Model	Lecture with PPT illustration	Short Test Formative assessment II
	2	Arrival process, Examples of arrival process	2	Recall the definitions and basic concepts of Poisson Distributions and Exponential Distributions	Lecture with illustration	

	3	Departure process, Queue with Combined Arrivals and Departure	3	Understand the theory of Queue with Combined Arrivals and Departure	Lecture with illustration	Quiz
	4	Problems based on Queue with Combined Arrivals and Departure	2	Formulate and solve Problems based on Queue with Combined Arrivals and Departure	Lecture with illustration	
	5	Queuing Models of Type : (M/M/1): (GD/∞/∞), Problems based on: (M/M/1): (GD/∞/∞)	3	Understand the theory of Queuing Models of Type : (M/M/1): (GD/∞/∞)	Lecture with discussion	
	6	Queuing Models of Type (M/M/1): (GD/N/∞) , Problems based on (M/M/1): (GD/N/∞)	3	Understand the theory of Queuing Models of Type : (M/M/1): (GD/N/∞)	Lecture with discussion	
V	**Types of Queuing Models**					
	1	Queuing Model (M/G/1): (GD/∞/∞), (M/M/C) : (GD/∞/∞), The Pollaczek-Khintchine Formula	4	Recall the definitions and basic concepts of Queuing Model	Lecture with illustration	Short Test

	2	Problems based on(M/M/C) : (GD/∞/∞), (M/M/∞) : (GD/∞/∞) Self service Model	4	Develop the knowledge of solving problems based on (M/M/C) : (GD/∞/∞), (M/M/∞) : (GD/∞/∞) model	Lecture with illustration	Assignment based on the queueing models
	3	(M/M/R) : (GD/K/K) R < K - Machine Service, Problems based on(M/M/R) : (GD/K/K) R < K - Machine Service	4	Develop the knowledge of solving problems based on (M/M/R) : (GD/K/K) R < K - Machine Service model	Lecture with illustration	
	4	Tandem or series queues	3	Develop the knowledge of Tandem or series queues	Lecture with illustration	

Course Instructor(Aided): Dr. L. Jesmalar HOD(Aided) :Dr. V. M. Arul Flower Mary

Course Instructor(S.F): Ms. C. JoselinJenisha HOD(S.F) :Ms. J. Anne Mary Leema

Semester : IV **Major Core XV**

Name of the course : Algorithmic Graph Theory

Course code : PM2044

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

Objectives:

1. To instill knowledge about algorithms.

2. To write innovative algorithms for graph theoretical problems.

Course Outcome

CO	Upon completion of this course the students will be able to :	PSO addressed	CL
CO - 1	understand basic algorithms and write algorithms for simple computing	PSO - 1	U E
CO - 2	analyze the efficiency of the algorithm	PSO - 2	An
CO - 3	understand and analyze algorithmic techniques to study basic parameters and properties of graphs	PSO - 2	R An
CO - 4	use effectively techniques from graph theory, to solve practical problems in networking and communication	PSO - 3	Ap

Total contact hours: 90 (Including lectures, seminar and tests)

Unit	Section	Topics	Lecture hours	Learning outcome	Pedagogy	Assessment/ Evaluation
I	**The Role of Algorithms in Computing and Getting Started**					
	1	Role of algorithms in computing- Algorithms, Data structures, Technique, Hard problems, Parallelism	4	Recall the definitions and understand the basic concepts of algorithms	Lecture with illustration	Evaluation through: Short Test
	2	Algorithms as a technology- Efficiency, Algorithms and other technologies	2	Analyze the efficiency of algorithms. Use algorithm as a technology	Lecture with illustration	Formative assessment I

	3	Insertion sort and its algorithm, Pseudocode conventions	3	Understand the algorithm of Insertion Sort. Express the fundamental concepts of pseudocode	Lecture with PPT illustration	
	4	Analyzing Algorithms- Worst-case and average-case analysis,	3	Express the fundamental concepts of algorithms, Demonstrate the use of algorithms in worst case and average case analysis	Lecture with illustration	
	5	Designing Algorithms -The divide-and-conquer approach and its algorithm, Analysis of merge Sort	3	Understand the divide-and-conquer approach and its algorithm. Analyze the Merge Sort Algorithm	Lecture with illustration	
II	**Elementary Graph Algorithms**					
	1	Representation of graphs – adjacency list representation, adjacency matrix representation	3	Recall the definitions and basic concepts of graph theory. Express the fundamental concepts of adjacency matrix representation	Lecture with illustration	Short Test Formative assessment I, II
	2	Definitions and Breadth first Search algorithms, Shortest paths and related Lemmas,	3	Recall the definitions and basic concepts of graph theory. Understand the algorithm of BFS	Lecture with PPT illustration	

		Corollary and correctness of Breadth first Search theorem				
	3	Breadth-first trees, related Lemma, Definitions and Depth first search algorithms	3	Recall the definitions and basic concepts of graph theory, Understand the algorithm of DFS	Lecture with PPT illustration	
	4	Parenthesis theorem, Corollary on nesting of descendant's intervals, White-path theorem	3	Understand the properties of DFS, Distinguish between BFS and DFS	Lecture with illustration	
	5	Topological Sort, Strongly Connected Components and related Lemmas and Theorems	4	Understand the algorithms of Topological Sort and Strongly Connected Components	Lecture with illustration	
III	**Growing a minimum spanning tree and The algorithms of Kruskal and Prim**					
	1	Theorem, Corollary related to Growing a minimum spanning tree	3	Understand the theory of spanning tree	Lecture with illustration	Short Test Formative assessment II
	2	Kruskal's algorithm	3	Recall the definitions and basic concepts of graph theory. Understand the theory of Kruskal's algorithm	Lecture with illustration	Assignment on minimum spanning tree

	3	Prim's algorithm, The execution of Prim's algorithm on the graph	4	Understand the theory of Prim's algorithm	Lecture with illustration	
	4	Problems based on minimum spanning tree	3	Recall the definitions and basic concepts of algorithms	Lecture with PPT illustration	
IV	**The Bellman – Ford algorithm and Dijkstra's algorithm**					
	1	Lemma and Corollary based on correctness of the Bellman-Ford algorithm	3	Understand the theory of Bellman-Ford algorithm	Lecture with PPT illustration	Short Test Formative assessment III
	2	Theorem and definition related to Single-source shortest paths in directed acyclic graphs	3	Recall the definitions and basic concepts of graph theory	Lecture with illustration	
	3	Dijkstra's algorithm, The execution of Dijkstra's algorithm	3	Understand the theory of Dijkstra'salgorithm	Lecture with illustration	
	4	Corollary and analysis of Dijkstra's algorithm	4	Understand the execution of Dijkstra's algorithm	Lecture with illustration	
	5	Difference Constraints and Shortest Paths-Systems of Difference Constraints, Constraint	3	Understand the concept of Difference Constraints and Shortest Paths	Lecture with illustration	

		graphs, Solving Systems of Difference Constraints				
V	**Shortest paths and Matrix multiplication, The Floyd-Warshall algorithm**					
	1	Computing the shortest-path weights bottom up algorithm	3	Recall the definitions and basic concepts of graph theory	Lecture with illustration	Short Test Formative assessment III Seminar on shortest paths
	2	Algorithm for matrix multiplication, Improving the running time and technique of repeated squaring	3	Develop the knowledge of shortest paths and establish new relationship in matrix multiplication	Lecture with illustration	
	3	The structure of a shortest path, A recursive solution to the all-pairs shortest paths problem	3	Develop the knowledge of shortest paths and establish new relationship in matrix multiplication	Lecture with illustration	
	4	Computing the shortest-path weights bottom up algorithm, Transitive closure of a directed graph algorithm	4	Develop the knowledge of shortest paths and establish new relationship in matrix multiplication	Lecture with PPT illustration	
	5	Johnson's Algorithm for Sparse Graphs-Preserving shortest paths by	2	Understand the theory of Johnson's Algorithm for Sparse Graphs	Lecture with illustration	

		reweighting and related Lemma				

Course Instructor(Aided): Dr. J. Befija Minnie HOD(Aided) :Dr. V. M. Arul Flower Mary

Course Instructor(S.F): Mrs.J.Anne Mary LeemaHOD(S.F) :Ms. J. Anne Mary Leema

Semester : IV **Elective IV (a)**

Name of the Course : Combinatorics

Course Code : PM2045

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

Objectives: 1. To do an advanced study of permutations and combinations.

2. Solve related real life problems.

Course Outcome

CO	Upon completion of this course the students will be able to :	PSO addressed	CL
CO - 1	discuss the basic concepts in permutation and combination, Recurrence Relations, Generating functions, The Principle of Inclusion and Exclusion	PSO - 1	U
CO - 2	distinguish between permutation and combination, distribution of distinct and non-distinct objects	PSO - 2	An
CO - 3	correlate recurrence relation and generating function	PSO - 2	An
CO -4	solve problems by the technique of generating functions, combinations, recurrence relations, the principle of inclusion and exclusion	PSO - 3	Ap
CO - 5	interpret the principles of inclusion and exclusion, equivalence classes and functions	PSO - 4	An E

Total contact hours: 90 (Including assignments and tests)

Unit	Section	Topics	Lecture hours	Learning Outcome	Pedagogy	Assessment Evaluation
I	1.	Permutations and combinations	1	To understand Permutations and combinations	Lecture, Illustration	Evaluation through : Class test Quiz Formative assessment- I
	2.	TheRules of sum and product	6	To define theRules of sum and product and to apply those definitions to solve problems	Lecture, Illustration, Group discussion, Problem Solving	
	3.	Permutations	4	To understand Permutations in detail and to apply the concepts to solve problems	Lecture, Illustration, Discussion, Problem Solving	
	4.	Combinations	3	To understand Combinations in detail and to apply the concepts to solve problems	Lecture, Illustration, Problem Solving	
	5.	Distribution of Distinct Objects and Distribution of Non distinct Objects	1	To understand the distribution of distinct and nondistinct objects	Lecture, Illustration	
II	1.	Generating Functions	4	To understand generating functions and their types	Lecture, Discussion	Formative assessment- I Multiple choice questions Class test
	2.	Generating Functions for Combinations	4	To understand the generating functions for combinations and use them to solve problems	Lecture, Group discussion, Problem Solving	

	3.	Enumerators for Permutations.	4	To understand the Enumerators for Permutations and use them to solve problems	Lecture, Illustration, Problem Solving	Formative assessment-I
		Distribution of distinct objects into nondistinct cells	1	To derive some results on the distribution of distinct objects into nondistinct cells	Lecture, Illustration, Problem Solving	
		Partitions of integers	1	To understand the concept and derive the partition of integers	Lecture, Illustration, Problem Solving	
		The Ferrers graph	1	To derive some results using Ferrers graph	Lecture, Illustration, Problem Solving	
III	1.	Recurrence Relations	5	To understand the recurrence relations	Lecture, Group discussion, Problem Solving	Multiple choice questions
	2.	Linear Recurrence Relations with Constant Coefficients	5	To understand the linear recurrence relations with constant coefficients and use them to solve problems	Lecture, Illustration, Problem Solving	Unit test Group Discussion
	3.	Solution by the Technique of Generating Functions	5	To solve problems by the technique of generating functions	Lecture, Problem Solving	Formative assessment- II
IV	1.	The Principle of Inclusion and Exclusion	1	To understandthe principle of inclusion and exclusion	Lecture, Group discussion	Formative assessment- II

	2.	The General Formula	1	To understandthe general formula	Lecture, Discussion	Seminar on permutations with restrictions on relative positions Assignment on derangements and the Rook polynomials Formative assessment- II
	3.	Derangements	5	To dearrange objects and to solve related problems	Lecture, Illustration, Problem Solving	
	4.	Permutations with Restrictions on Relative Positions	4	To learn permutations with restrictions on relative positions	Lecture, Discussion, Problem Solving	
	5.	The Rook Polynomials	4	To understand the Rook polynomials and to solve related problems	Lecture, Problem Solving	
V	1.	Polya's Theory of Counting	1	To understand Polya's theory of counting	Lecture, Illustration	Seminar on equivalence classes under a permutation group and functions Short test Formative assessment- II
	2.	Equivalence Classes under a Permutation Group	5	To understand equivalence classes under a permutation group	Lecture, Discussion, Problem Solving Problem Solving	
	3.	Equivalence classes of Function	4	To understand equivalence classes of function	Lecture, Group discussion, Problem Solving	
	4.	Weights and Inventories of Functions	4	To understand weights and inventories of functions	Lecture, Illustration, Problem Solving	
	5.	Polya's Fundamental Theorem.	1	To understand and prove Polya's fundamental theorem	Lecture	

Course Instructor(Aided): Dr. S. Sujitha HoD(Aided) :Dr. V. M. Arul Flower MaryCourse Instructor(S.F) : Ms. R.N.Rajalekshmi HoD(SF)

:Ms. J. Anne Mary Leema