Department of Mathematics

Semester : II **Major Core IV**

Name of the Course : Algebra II

Subject code : PM1721

Teaching Plan

Unit	Modules	Topics	Lecture hours	Learning outcomes	Pedagogy	Assessment/ evaluation
I	**Vector spaces and Inner Product Space**					
	1	Subspaces, Quotient Spaces	4	To recall and apply the definition of vector spaces	Lectures, Assignments	Test
	2	Homomorphisms of Linear Transformations	4	To recall the definitions of homomorphism	Lectures, Assignments	Test
	3	Linear Span , Linear Dependence and Independence	4	To use the basic concepts dimension, basis, rank and nullity in analyzing matrices	Lectures, Assignments	Test
	4	Inner Product Space - Norm of a vector, Orthogonality and Orthonormal sets	4	Compute inner products and determine orthogonality on vector spaces, including Gram-Schmidt Orthogonalization.	Lectures, Online Assignments	Test
II	**Linear Transformations**					
	1	Algebra of linear transformations	4	To use the definition and properties of Linear transformation in solving problems	Lectures, Assignments	Test
	2	Invertible linear transformations	3	To understand the concept matrices of Linear transformations and change of basis including kernel and range.	Lectures, Seminars	Test
	3	Matrix of a linear transformation	3	To apply the principles and properties of matrix algebra in linear transformations	Lectures, Group Discussion	Quiz
	4	Dual spaces	5	To understand the theorems in dual spaces	Lectures, Assignments	Test
	5	Transpose of a linear transformation		To understand the concept Transpose of a linear transformation and to solve problems	Lectures, Seminars	Assignment
III	**Eigen values and Eigen vectors**					
	1	Characteristic	4	To write the characteristic	Lectures, Assignments	Quiz

		polynomials		polynomials		
	2	Characteristic polynomial of a linear operator	3	To demonstrate the characteristic polynomial of a linear operator	Online Assignments	Test
	3	Minimal polynomials	3	To determine the minimal polynomials	Lectures, Seminars	Test
	4	Diagonolizable operators	3	To diagonalise the symmetric matrices	Group Discussions, Online Assignments	Assignment
	5	Primary decomposition theorem		To understand and apply the Primary decomposition theorem	Lectures	Formative Assessment Test
IV	**Invariant subspaces**					
	1	Invariant subspaces	4	To understand the concept Invariant subspaces	Lectures, Group discussion	Test
	2	Triangulable linear operator	3	To use triangulable linear operator in solving problems	Lectures	Test
	3	Cyclic subspaces, T-annihilator	5	To understand the theorems in Cyclic subspaces and T-annihilator	Lectures, Group discussion	Quiz, Test
	4	Projection	2	To demonstrate the concept and to solve problems	Lectures, Assignments	Assignment
V	**Fields**					
	1	Algebraic extensions	3	To recall the definition of fields and to learn the concept Algebraic extensions	Lectures, Group discussion	Test
	2	Roots of polynomials	3	To determine the roots of polynomials	Lectures, Assignments	Formative Assessment test
	3	Splitting fields	4	To demonstrate the concept and to solve problems	Lectures, Group discussion	Test

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Semester : II **Major Core VI**
Name of the Course : Analysis II
Subject code : PM1722

Teaching Plan

Unit	Modules	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	Q&A
	3	Properties of Riemann Stieltjes integrals	3	To understand the properties of Riemann Stieltjes integrals	Lecture with Illustration	Open Book Assignment
	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	Group Discussion
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	6	To distinguish between convergence and uniform convergence	Lecture	Open book assignment
	3	Theorems based on uniform convergence and differentiation	3	To understand the relation between the uniform convergence and differentiation	Lecture	Q&A
	4	Problems based on sequences and series of functions	3	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 clousure	4	To understand the concept of uniformly closed algebra in various	Lecture with Illustration	SlipTest

				theorems		
	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 equicontinuous and solve problems	Group Discussion	Brain Storming
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	Test
	4	Problems related to Fourier Series	4	To understand the significance of Fourier series and apply it in problems	Lecture with Illustration	Formative Assessment Test
V	**Differentiation**					
	1	Introduction of differentiation , Definition of total derivative and examples	4	To identify total derivative problems	Lecture with Illustration	Test
	2	Theorems and examples based on Partial derivatives	4	To apply the concept of Partial derivatives	Lecture with Illustration	Q&A
	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	Quiz and Test

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Semester : II Major Core VII
Name of the Course : Partial Differential Equations
Subject code : PM1723

Unit	Modules	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	3	To Recall the definitions of complete integral, particular	Lecture	Quiz

		compactible system		integral and singular integral		
	2	Charpit's Method and problems, Problems related to charpit's method	4	To Analyze Charpit'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 discussio n	Test
	5	Problems related to charpit's method	3	To Learn Charpit's Method methods to solve the problems	Lecture	Assignment
II	**Special methods of solutions applicable to certain standard forms**					
	1	Standard form I, Examples related to standard form I	4	To solve problems related to standard form I	Lecture with group discussion	Test
	2	Standard form II, Examples related to standard form II	3	To solve problems related to standard form II	Lecture	Quiz
	3	Standard form III, Problems based on Standard form III	3	To solve problems related to standard form III	Lecture	Formative Assessment
	4	Standard form IV and examples	2	To solve problems related to standard form IV	Lecture	Test
	5	Jacobi's Method for solving a non- linear first order partial differential equation and Examples, Cauchy's Method for solving a non- linear partial differential equation	3	Learn some methods to solve the problems of non- linear partial differential equation	Lecture with group discussion	Test
III	**Homogeneous linear partial differential equation with constant coefficient**					
	1	Homogeneous and non-homogeneous linear equation with constant coefficient, Solution of finding homogeneous equation with constant coefficient, Theorem I, II	2	To Analyze homogeneous linear partial differential equations with constant coefficients	Lecture	Test
	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	3	To find Complementary	Lecture	Test

		Complementary function		function		
	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
IV	**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 complementary function	2	Analyze non-homogeneous linear partial differential equations with constant coefficients and to solve the problems	Lecture with group discussion	Quiz
	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
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	2	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	2	To find the Solution of two dimensional	Lecture	Test

				Laplace's equation		
	5	Solution of two dimensional heat equation	2	To Apply the concepts and methods in physical processes like heat transfer and electrostatics	Lecture	Assignment

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Semester : II
Name of the Course : Graph Theory Major Core VIII
Subject Code : PM1724

Teaching Plan

Unit	Modules	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, Geodetic Sets - Definitions and Examples, Theorem based on Geodetic Sets	4	Understand the concept of Harary graphs and Geodetic Sets.	Lecture	Test
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 labelling	3	To understand the definitions of Hamiltonian cycles, Decompositions and Graceful Labelings		
IV		**Planarity and Coloring**				
	1	Planar Graphs Planar Graphs - Definitions and Examples, The Euler Identity, Consequence of Euler Identity, Theorems related to Planar Graphs	3	Cite examples of planar and nonplanar graphs	Lecture with illustration	Quiz
	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	3	To practice various Theorems	Lecture	Test

		triangle - free graph				
	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	**Ramsey Numbers & Distance**					
	1	The Ramsey Number of Graphs, Ramsey's Theorem based on Ramsey Number of Graphs, Illustrations for Ramsey Number	3	Determine the Ramsey number of certain graphs	Lecture with illustration	Quiz
	2	Theorems based on Ramsey Number of Graphs, Turan's Theorem,	3	To practice various Theorems	Lecture	Test
	3	Theorems based on Turan's Theorem, Theorem based on triangle	3	To practice various Theorems	Lecture	Formative Assessment Test
	4	Investigating the maximum size of a non-Hamiltonian graph, Theorem related to Hamiltonian, Distance - The center of a graph, Definitions and examples	3	To identify the center of a graph	Lecture	Assignment
	5	Theorems based on center of a graph, Distant Vertices, Theorems based on eccentricity, Theorems based on boundary vertex	3	To practice various Theorems	Lecture	Assignment

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Semester : II **Elective II**
Name of the Course : Classical Dynamics
Subject code : PM1725

Teaching Plan

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

		generalized coordinates , degrees of freedom, configuration space		ordinates, 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, Non holonomic 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's system	3	To understand Routhian Function, Conservative systems, Natural systems and Liouville's system	Lecture	Test
III	**Hamilton's Principle**					
	1	Stationary values of a function, 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 of least action, Problems based on other Variational Principles	3	To understand Modified Hamilton's Principle ,Principle of least action and Problems based on other Variational Principles	Lecture	Formative Assessment
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 equation with Illustration	Lecture	Test
	3	Any complete solution of the Hamilton - Jacobi equation leads to a solution of the Hamilton	3	Evaluating any complete solution of the Hamilton -	Lecture	Test

		Problem		Jacobi equation		
	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 Ignorable coordinates	3	To understand Ignorable coordinates, Modified Hamilton - Jacobi equation with Examples	Lecture and discussi on	Test
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 Lagrange and Poisson brackets, The bilinear Covariant	3	To understand Lagrange and Poisson brackets, Problems based on Lagrange and Poisson brackets and the bilinear Covariant	Lecture	Formative Assessme nt

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Semester : IV **Major Core XII**

Name of the Course :Complex Analysis

Subject code : PM1741

Teaching Plan

Unit	Section	Topics	Lecture hours	Learning outcomes	Pedagogy	Assessment /evaluation
I	**Complex Functions**					
	1	Introduction to theConcept of Analytic Function - Analytic functions	4	To understand the concept of analytic function	Lecture with illustration	Test
	2	Polynomials	2	To understand the concept and practice theorems	Lecture with illustration	Test
	3	Rational functions	4	To understand the concept and practice theorems	Video	Test
	4	Elementary Theory of Power Series-Sequences, Series	2	To understand the concept of sequences & series	Lecture	Test
	5	Uniform Convergence	2	To understand the concept Uniform Convergence and develop theorems	Lecture with group disscussion	Formative Assessment Test I
II	**Power series**					
	1	Definition and Problems related to Power Series and Radius of Convergence	4	To understand the definition of Power Series and Radius of Convergence and solve problems based on the concept	Lecture with group disscussion	Assignment
	2	Abel's theorem, Abel's limit theorem	3	To understand the concept and practice theorems	Lecture	Quiz
	3	The Exponential	3	To understand the concept and practice theorems and solve problems based on the concept	Lecture with illustration	Formative Assessment Test I &II
	4	Trigonometric functions, The periodicity	4	To understand the concept of Trigonometric functions& The periodicity and solve problems based on the concept	Lecture with group disscussion	Test
III	**Analytic functions as mappings**					
	1	conformality - Arcs and	5	To understand the	Lecture	Test

		closed curves, Analytic Functions in Regions		definition of Arcs and closed curves& Analytic Functions in Regions	with illustration	
	2	Conformal Mapping	3	To understand the concept of Conformal Mapping	Lecture	Test
	3	Length and Area, Linear transformations - The linear group	2	To understand the concepts and give illustrations	Lecture	Quiz
	4	The Cross Ratio, Symmetry	5	To understand the concepts of The Cross Ratio&Symmetry and develop theorems.	Lecture with group disscussion	Formative Assessment Test II
IV	**Complex Integration**					
	1	Fundamental theorems - Line Integrals ,Rectifiable Arcs	4	To understand the concept and practice theorems	Lecture with illustration	Test
	2	Line Integrals as Functions of Arcs, Cauchy's Theorem for a Rectangle, Cauchy's Theorem in a Disk	4	To practice theorems based on this concepts	Lecture	Test
	3	Cauchy's integral formula, The Index of a Point with Respect to a Closed Curve	3	To understand the concept and practice theorems related to this concepts.	Lecture with illustration	Test
	4	The Integral Formula, Higher Derivatives	2	To solve problems using this concepts.	Lecture	Formative Assessment Test II &III
	5	Local Properties of Analytic Functions - Removable singularties and Taylor's theorem, Zeros and poles.	4	To understand the concepts and give illustrations& practice theorems	Seminar	
V	**The local mapping**					
	1	The maximum principle, The General Form of Cauchy's Theorem	5	To understand the concept and practice theorems related to this concepts.	Lecture with illustration	Assignment
	2	Chains and Cycles, Simple Connectivity, Homology	3	To understand the concept and practice theorems related to this concepts.	Lecture with illustration	Quiz
	3	The General Statement of Cauchy's Theorem (statement only), The Calculus of Residues	3	To understand the concept about Calculus of Residues.	Lecture	Test
	4	The Residue Theorem, The Argument Principle	2	To understand the concept and practice	Lecture with illustration	Formative Assessment

				theorems related to this concepts.		Test III
	5	Evaluation of Definite Integrals.	2	To solve problems related to Definite Integrals.	Video	Test

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Semester : IV **Major Core XIII**
Name of the Course : Functional Analysis
Subject code : PM1742

Teaching Plan

Unit	Section	Topics	Lecture hours	Learning outcomes	Pedagogy	Assessment/ evaluation
I	**Normed linear space**					
	1.	Definition and, examples of a normed linear space and a Banach Space, Small preliminary results,Theorem-N/M is a Banach space	2	To understand the concept ofnormed linear space	Lecture	Test
	2.	Properties of a Closed unit sphere Holder's Inequality and Minkowski's Inequality, Equivalent conditions theorem on continuous linear transformations	3	To understand the Properties of a Closed unit sphere	Lecture with illustrations	Group Discussion
	3.	$B(N,N^1)$is a Banach space,Functionals and it's properties	2	To understand the concept ofFunctionals and it's properties	Lecture	Test
	4.	Definition of an Operator and small results on operators Side result of Hahn Banach theorem Hahn Banach theorem	4	Defining the Operator	Lecture	Test
	5.	Theorem based on N*, Theorem based on functional in N*, Problems based on Normed linear spaces	2	To apply the definitions to prove the theorem	Lecture with illustrations	Group discussion
II	**Conjugate space**					
	1.	Definitions of second conjugate space, induced functional,weak topology, weak* topology,strong	5	To understand the definition of conjugate space,weak* topology,strong topology.	Lecture	Test

		topology,B(N,N1)is a Banach space Functionals and it's properties				
	2.	Theorem on isometric isomorphism of Open mapping theorem) Open mapping theorem	5	To apply the definition and Lemmato prove the theorem	Lecture	Q&A
	3.	Theorem on Projection Closed Graph TheoremUniform , Boundedness Theorem on isometric isomorphism	5	To practice theorems related to this concepts.	Lecture	Formative Assessment Test
III	**Hilbert Space**					
	1.	Definition and examples,Properties of a Hilbert Space,Schwarz Inequality,Parallelogram lawTheorem on Convex subset of a Hilbert Space	3	To understand the Definition of a Hilbert Space	Lecture	Quiz
	2.	Theorem on Orthogonal Complements, Theorem on Orthogonal Complements, Theorem on closed linear subspaces	2	To apply the laws to prove the theorem	Lecture with illustration	Test
	3.	Theorem on the direct sum of closed linear subspace M of a Hilbert Space and $M^{\perp}$ Bessel's Inequality Orthonormal Sets	5	To apply the Bessel's Inequality on Theorems	Lecture with group discussion	Brain storming
	4.	Theorems on Orthonormal Sets Gram –Schmidt Orthogonalization Process Theorem on Conjugate Space H*	5	To understand the concept of Schmidt Orthogonalization Process	Lecture	Assignment
IV	**Adjoint operator**					
	1.	Definition and small results, Theorem on the properties of an adjoint operator Theorem on the properties of an adjoint operator	3	Acquire the knowledge about properties of an adjoint operator	Lecture with illustration	Q&A
	2.	Theorem-The set of all self adjoint operators is a real Banach space, Theorems on self adjoint operators Theorems on self adjoint	3	Applying theorems on self adjoint operators	Lecture	Q&A

		operators				
	3.	Properties on Normal and Unitary Operators , Theorems on Normal and Unitary Operators, Theorems on Normal and Unitary Operators, Projections-Definitions and preliminaries Theorems on Projections	5	Acquire the knowledge about Normal and Unitary Operators	Lecture	Slip Test
	4.	Theorems on Projections, Theorems on invariant subspace Projection theorem Problems on Projections	4	Apply the concept of invariant subspace on theorems	Lecture	Formative Assessment Test
V		**Eigen vectors and Eigen values**				
	1.	Eigen vectors and Eigen values, Results on Eigen vectors and Eigen values, Properties of matrices	3	To understand the definition of Eigen vectors and Eigen values	Lecture with illustration	Quiz
	2.	Properties of matrices Theorems on Matrices, Theorem on similar matricesand Properties of Determinants	4	To categorize the Properties of matrices on Theorems	Lecture	Test
	3.	Properties of Determinants, Theorems on Determinants, Theorems on Determinants and Side results of Spectral Theorem	5	To know Properties of Determinants	Lecture	Slip Test
	4.	Spectral Theorem and Spectral Resolution Theorem on Spectral Resolution	4	To apply the previous results on Spectral Theorem	Lecture	Assignment

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Semester : **IV** **Major Core XIV**
Name of the course : Operations Research
Course code : **PM1743**

Teaching Plan

Unit	Modules	Topics	Lecture hours	Learning outcome	Pedagogy	Assessment/ Evaluation
I	**Elements of DP model**					
	1	Elements of the DP Model, Network model, Backward recursive equation	4	Recall the definitions and basic concepts of linear programming, Express the fundamental concepts of network model	Lecture with illustration	Short Test Formative assessment I
	2	More on the definition of the state Examples of DP models and computation	3	Express the fundamental concepts of dynamic programming	Lecture with PPT illustration	
	3	Reliability problem, Optimal subdivision problem, Forward and backward recursive equation	3	Understand the significance and application of Reliability problem, Optimal subdivision problem , backward recursive equation	Lecture discussion	
	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	
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, II Seminar on Arrow (Network) Diagram
	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	Lecture with PPT illustration	

				floats		
	3	Construction of the Time Chart and Resource Leveling, Problems based on Time Chart and Resource Leveling	4	Understand the construction of the Time Chart and Resource Leveling, Problems based on Time Chart	Lecture with PPT illustration	
	4	Probability and Cost Considerations in Project Scheduling . Problems based on Probability and Cost Considerations in Project Scheduling .	2	Understand the properties of Probability and Cost Considerations in Project Scheduling	Lecture with discussion	
III	**Generalised 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 Seminar on Generalised Inventory model
	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	
	3	Single Item Static Model with Price Breaks, Problems based on Single Item Static Model with Price Breaks	3	Understand the theory of Single Item Static Model with Price Breaks	Lecture with illustration	
	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, Planning horizontal theorem	2	Understand the theory of Single – Item static Model with Storage Limitations, Planning horizontal theorem	Lecture with discussion	
IV	**Queueing Model**					
	1	Basic Elements of the Queueing Model, Roles of Poisson Distributions, Roles of Exponential Distributions	3	Understand the theory of Queueing Model	Lecture with PPT illustration	Short Test Formative assessment III
	2	Arrival process, Examples of arrival process	2	Recall the definitions and basic concepts of Poisson	Lecture with illustration	

				Distributions and Exponential Distributions		
	3	Departure process, Queue with Combined Arrivals and Departure	3	Understand the theory of Queue with Combined Arrivals and Departure	Lecture with illustration	
	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	Queueing Models of Type : (M/M/1): (GD/∞/∞), Problems based on: (M/M/1): (GD/∞/∞)	3	Understand the theory of Queueing Models of Type : (M/M/1): (GD/∞/∞)	Lecture with discussion	
	6	(M/M/1): (GD/N/∞) , Problems based on (M/M/1): (GD/N/∞)	3	Understand the theory of Queueing Models of Type : (M/M/1): (GD/N/∞)	Lecture with discussion	
V	**Types of Queueing Models**					
	1	Queueing Model (M/G/1): (GD/∞/∞), (M/M/C) : (GD/∞/∞)	4	Recall the definitions and basic concepts of Queueing Model	Lecture with illustration	Short Test Formative assessment III
	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	
	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 PPT illustration	

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Semester : IV **Major Core XV**
Name of the course : Algorithmic Graph Theory
Course code : PM1744

Teaching Plan

Unit	Modules	Topics	Lecture hours	Learning outcome	Pedagogy	Assessment/ Evaluation
I	**The Role of Algorithms in Computing and Getting Started**					
	1	Role of algorithms in computing, Data structures and technique	4	Recall the definitions and basic concepts of graph theory, Express the fundamental concepts of algorithms	Lecture with illustration	Evaluation through: Short Test Formative assessment I
	2	Algorithms and other technologies	4	Express the fundamental concepts of technologies	Lecture with PPT illustration	
	3	Insertion sort and its algorithm, Pseudocode conventions	4	Recall the definitions and basic concepts of graph theory, Express the fundamental concepts of pseudocode	Lecture with illustration	
	4	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	
II	**Elementary Graph Algorithms**					
	1	Representation of graphs – adjacency list representation, adjacency matrix representation	4	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, Corollary and correctness of Breadth	4	Recall the definitions and basic concepts of graph theory, Understand the algorithm of BFS	Lecture with PPT illustration	

		first Search theorem				
	3	Breadth-first trees, related Lemma, Definitions and Depth first search algorithms	4	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	5	Understand the properties of DFS, Distinguish between BFS and DFS	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 Assignment on minimum spanning tree
	2	Kruskal's algorithm	3	Recall the definitions and basic concepts of graph theory, Understand the theory of Kruskal's algorithm	Lecture with illustration	
	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	5	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's algorithm	Lecture with illustration	
	4	Corollary and analysis of Dijkstra's algorithm	4	Understand the execution of Dijkstra's algorithm	Lecture with illustration	
V	**Shortest paths and Matrix multiplication, The Floyd-Warshall algorithm**					
	1	Computing the shortest-	3	Recall the	Lecture	Short Test

		path weights bottom up algorithm		definitions and basic concepts of graph theory	with illustration	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	4	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	

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Semester: IV **Elective IV**

Name of the Course:Combinatorics

Subject Code:PM1745

Teaching Plan

Unit	Modules	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.	The Rules of sum and product	6	To define the Rules 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	1	To understand the distribution of distinct objects	Lecture, Illustration	
II	1.	Generating Functions	5	To understand generating functions and their types	Lecture, Discussion	Formative assessment- I Multiple choice questions Short test Formative assessment-II
	2.	Generating Functions for Combinations	5	To understand the generating functions for combinations and use them to solve problems	Lecture, Group discussion, Problem Solving	
	3.	Enumerators for	5	To understand the Enumerators	Lecture, Illustration,	

		Permutations .		for Permutations and use them to solve problems	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
	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 understand the principle of inclusion and exclusion	Lecture, Group discussion	Formative assessment- II
	2.	The General Formula	1	To understand the general formula	Lecture, Discussion	Seminar on permutations with restrictions on relative positions
	3.	Derangements	5	To dearrange objects and to solve related problems	Lecture, Illustration, Problem Solving	Assignment on derangements and the Rook polynomials
	4.	Permutations with Restrictions on Relative Positions	4	To learn permutations with restrictions on relative positions	Lecture, Discussion, Problem Solving	Formative assessment- III
	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
	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	Short test
	4.	Weights and Inventories of Functions	4	To understand weights and inventories of functions	Lecture, Illustration, Problem Solving	Formative assessment- III
	5.	Polya's Fundamental Theorem.	1	To understand and prove Polya's fundamental theorem	Lecture	

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