Department of Mathematics

PG Teaching Plan 23-24

Even Semester

Department : Mathematics

Class : I M.Sc

Semester : II

Name of the Course : Advanced Algebra

Course Code : MP232CC1

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP232CC1	5	1	-	-	5	6	90	25	75	100

Learning Objectives

1. To study field extension, roots of polynomials, Galois Theory, finite fields, division rings, solvability by radicals
2. To develop computational skill in abstract algebra.

Course Outcomes

On the successful completion of the course, students will be able to:		
1.	exhibit a foundational understanding of essential concepts, including field extensions, roots of polynomials, Galois Theory, and finite extensions	**K1**
2.	demonstrate knowledge and understanding of the fundamental concepts including extension fields, Galois Theory, Automorphisms and Finite fields	**K2**
3.	compose clear and accurate proofs using the concepts of Field extension, Galois Theory and Finite field	**K3**
4.	examine the relationships between different types of field extensions and their implications by applying algebraic reasoning	**K4**
5.	evaluate the validity of statements and theorems in field theory by providing proofs or counterexamples	**K5**
6.	develop novel results or theorems in field theory, potentially by exploring	**K6**

	extensions of existing theories	

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

Unit	**Module**	**Topic**	**Teaching Hours**	**Cognitive level**	**Pedagogy**	**Assessment/ Evaluation**
I	Extension Fields					
	1.	Extension Fields, dimension, subfield-Introduction and definition	2	K1 & K2	Brainstorming	MCQ
	2.	Theorems based on extension fields	3	K3	Chalk and Talk	Slip Test using Socrative
	3.	Definition and Theorems on algebraic over a field F	3	K1 & K3	Analytic Method	Questioning
	4.	Theorems on algebraic extension	3	K5	Lecture with Illustration	Questioning
	5.	Interpretation of Extension fields such as finite extension, algebraic extension	1	K4	Collaborative learning	Concept explanations
	6.	Transcendence of e	3	K2, K3 & K5	Blended classroom	Evaluation through poll
II	Roots of Polynomials					
	1.	Definition- roots of polynomials, multiplicity of roots	1	K1	Brainstorming	True/False
	2.	Remainder theorem	1	K3	Flipped Classroom	Short summary of the theorem
	3.	Theorems based on roots of polynomials	2	K2 & K3	Lecture Discussion	Concept definitions
	4.	Existence theorem of splitting fields	2	K3 & K4	Group Discussion	Recall steps
	5.	Theorems based on isomorphism of fields	2	K3	Lecture with Illustration	Questioning
	6.	Theorems based on splitting field of polynomials	2	K3	Blended classroom	MCQ
	7.	Uniqueness theorem of splitting fields	2	K4 & K5	Peer Instruction	Slip Test using Quizziz
	8.	Definition- derivative of polynomials, Simple extension	1	K2 & K3	Flipped Classroom	Quiz
	9.	Theorems on simple extension	2	K5& K6	Integrative method	Evaluation through short test
III	Galois Theory					
	1.	Definition -Fixed Field, Group of automorphism	1	K1 & K2	Brainstorming	Quiz

	2.	Theorems on Fixed Field	2	K3	Lecture	Concept Explanation
	3.	Theorems on Group of Automorphism	3	K4	Lecture Discussion	Slip Test
	4.	Theorems on Normal Extension	2	K5	Lecture	Questioning
	5.	Theorems on Galois Group	3	K6	Collaborative learning	Questioning
	6.	Construct theorems on Normal Extension and Galois Group	4	K6	Poster Presentation	Simple Questions
IV	Finite Fields					
	1.	Definition -Finite Fields, Characteristic of F with examples	3	K1 & K2	Brainstorming	Quiz
	2.	Theorems based on Finite Fields and Characteristic of F	4	K3 & K4	Flipped Classroom	Differentiate between various ideas
	3.	Finite field and Cyclic group	4	K4 & K5	Analytic Method	Simple Questions
	4.	Wedderburn's Theorem on finite division ring	4	K4 & K5	Integrative method	Concept Explain
V	Solvability by Radicals					
	1.	Solvability by radicals - Introduction	1	K1 & K2	Seminar Presentation	MCQ
	2.	Solvable and Commutator group	1	K4	Seminar Presentation	Concept explanations
	3.	Lemma and Theorem based on solvable by radicals	1	K4 & K5	Seminar Presentation	Questioning
	4.	General polynomial definition and theorem	2	K2 & K3	Seminar Presentation	Slip Test
	5.	Definitions -algebraic over F and Frobenius theorem	4	K2 & K5	Seminar Presentation	Simple Questions
	6.	Internal quaternions and Lagrange identity	2	K4	Seminar Presentation	Evaluation through short test
	7.	Left-Division algorithm	3	K6	Seminar Presentation	Simple Questions
	8.	Four-Square Theorem	3	K6	Seminar Presentation	Simple Questions

Course Focussing on Employability/ Entrepreneurship/ Skill Development:**Employability**

Activities (Em/ En/SD):**Poster Presentation, Develop Theorems on Extension Fields**

Course Focussing on Cross Cutting Issues (Professional Ethics/ Human Values/Environment Sustainability/ Gender Equity): -

Activities related to Cross Cutting Issues: -

Assignment:**Make an interactive PPT (Any topic from the syllabus)**

Seminar Topic: **Unit V**

Sample questions

Part A

1. Complete: [L:F] =--------------------
   a) [L:K]+ [K:F] b) [L:K]-[K:F] c) [L:K][K:F] d) [L:K]/[K:F]
2. Complete: Any polynomial of degree n over a field can have ---------------- roots in any extension field.
   a) exactly n b) at least n c) at most n d) exactly n+1
3. What is the Galois group of x^3 -3x -3 over Q ?
4. Say True or False: $\Phi_3(x) = x^2 + x + 1$ is a cyclotomic polynomial
5. Say True or False: The adjoint in Q satisfies $x^{**} = x$

Part B

1. Prove that F(a) is the smallest subfield of K containing both F and a
2. State and prove Remainder theorem
3. If K is a finite Extension of F ,then G(K,F) is a finite group then prove that o(G(K,F)) $\leq$ [K:F]
4. Analyse: For every prime number p and every positive integer m there is a unique field having p^m elements
5. State and prove Lagrange Identity.

Part C

1. Prove that the element a $\in$ K is algebraic over F if and only if F(a) is a finite extension of F
2. Justify: A polynomial of degree n over a field can have at most n roots in any extension field
3. State and prove fundamental theorem of Galois theory
4. Prove that, the multiplicative group of nonzero elements of a finite field is cyclic.
5. Justify: Every positive integer can be expressed as the sum of squares of four integers.

Head of the Department | **Course Instructor**

Dr. T. Sheeba Helen | **Dr. S. Sujitha**

Department :Mathematics
Class :IM.Sc
Semester :II
Name of the Course: Real Analysis – II
CourseCode :MP231CC5

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP231CC5	5	1	-	-	5	6	90	25	75	100

Learning Objectives

1. To introduce measure on the real line, Lebesgue measurability and integrability, Fourier Series and Integrals.
2. To get the in-depth study in multivariable calculus.

Course Outcomes

On the successful completion of the course, students will be able to:		
1.	recall and describe the basic concepts of measure, integration of functions, Fourier series on real line and multivariable differential calculus, implicit functions and extremism problems.	**K1 & K2**
2.	compare Boral measure with Lebesgue measure and the total derivatives with partial derivatives.	**K3**
3.	determine the matrix representation and Jacobian determinant of functions.	**K3**
4.	analyze the properties of measurable functions, Riemann and Lebesgue Integrals, convergence of Fourier series and extrema of real valued functions.	**K4**
5.	test measurable sets and measurable functions.	**K5**

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

Unit	**Module**	**Topic**	**Teaching Hours**	**Cognitive level**	**Pedagogy**	**Assessment/ Evaluation**
I	**Measure on the Real line**					
	1.	Lebesgue Outer Measure	3	K1&K2	Brainstorming	Questioning
	2.	Measurable sets	4	K2& K5	Lecture Method & Seminar Presentation	Quiz through Quizziz
	3.	Regularity	2	K3	Content based & Seminar Presentation	Questioning
	4.	Measurable Functions	4	K2&K5	Lecture withIllustration	Oral Test
	5.	Borel and Lebesgue Measurability	2	K2 &K3	Collaborativelearning	Conceptexplanations
II	**Integration of Functions of a Real variable**					
	1.	Integration of Non-negative functions	5	K1& K2	Brainstorming& Seminar Presentation	Quiz through Slido
	2.	The General Integral	5	K3	FlippedClassroom and Seminar Presentation	Home Work
	3.	Riemann and Lebesgue Integrals.	5	K2&K4	Lecture& Seminar presentation	Conceptdefinitions

III	**Fourier Series and Fourier Integrals**					
	1.	Orthogonal system of functions - The theorem on best approximation	3	K1&K2	Brainstorming	Quiz through Socrative
	2.	The Fourier series of a function relative to an orthonormal system - Properties of Fourier Coefficients	2	K4	Lecture	Questioning
	3.	The Riesz-Fischer Thorem - The convergence and representation problems for trigonometric series - The Riemann - Lebesgue Lemma	4	K3	Content Based	ConceptEx planation
	4.	The Dirichlet Integrals - An integral representation for the partial sums of Fourier series	4	K4	Flipped Class Room & Seminar Presentation	SlipTest
	5.	Riemann's localization theorem - Sufficient conditions for convergence of a Fourier series at a particular point	4	K4	Lecture	Home Work
	6.	Cesaro summability of Fourier series- Consequences of Fejes's theorem - The Weierstrass approximation theorem	3	K4	Collaborative learning	Recall Concepts
IV	**Multivariable Differential Calculus**					
	1.	The Directional derivative - Directional derivative and continuity	4	K1&K2	Brainstorming	Quiz through Quizziz

	2.	The total derivative - The total derivative expressed in terms of partial derivatives-An application to complex-valued functions	4	K2&K3	FlippedClass room	Differentiate between various ideas
	3.	The matrix of linear function - The Jacobian matrix	2	K3	Illustrative Method	Simple Questions
	4.	The chain rule - Matrix form of chain rule	3	K2 & K3	Lecture Method	Concept Explain
	5.	The mean - value theorem for differentiable functions - A sufficient condition for differentiability	3	K4	Content Based	Home Work
	6.	A sufficient condition for equality of mixed partial derivatives	2	K4	Lecture Method	Slip Test
	7.	Taylor's theorem for functions of R^n to R^1	2	K4	Content Based	Short Answer Test
V	**Implicit Functions and Extremum Problems**					
	1.	Functions with non-zero Jacobian determinants	4	K2&K3	Content Based	Questioning
	2.	The inverse function theorem	3	K3	Analytic Method	Concept explanations
	3.	The Implicit function theorem-	3	K3	Lecture Method	Questioning
	4.	Extrema of real valued functions of severable variables	5	K2 & K4	Content Based and Seminar Presentation	Home Work
	4.	Extremum problems with side conditions.	5	K4	Lecture Method	SlipTest

Course Focusing on Employability/Entrepreneurship/ SkillDevelopment: **Employability**
Activities(Em/En/SD):**PosterPresentation and Model Making**

Assignment:**MakeaninteractivePPT using AI (Anytopicfromthesyllabus)**
SeminarTopic:**Problems in the Exercises**

Sample Questions

Part A

1. A function is said to be periodic with period $\boldsymbol{p \neq 0}$ if . . ..
2. The directional derivative of $\boldsymbol{f}$ at $\boldsymbol{c}$ in the direction $\boldsymbol{u}$is . .. .
3. Let $\boldsymbol{B = B(a,r)}$ be an n-ball in $\boldsymbol{R^n}$. Then $\boldsymbol{\partial B} =$ . . . .

Part B

1.
2. Assume that $\boldsymbol{g(0+)}$ exists and suppose that for some $\boldsymbol{\delta > 0}$ the Lebesgue integral $\int_0^{\delta} \frac{g(t)-g(0+)}{t}\, dt$ exists. Prove that $\lim_{n\to\infty} \frac{2}{\pi}\int_0^{\delta} g(t)\frac{\sin \alpha t}{t}\, dt = g(0+)$.
3. Let $\boldsymbol{f = u + iv}$. Show that Cauchy-Riemann equations along with differentiability of u and v, imply that $\boldsymbol{f'(c)}$.
4. Let $\boldsymbol{f}$ be a real – valued function with continuous second –order partial derivatives at a stationary point $\boldsymbol{a}$ in $\boldsymbol{R^2}$. Let $\boldsymbol{A = D_{1,1}f(a), B = D_{1,2}f(a), C = D_{2,2}f(a)}$ and let $\boldsymbol{\Delta = det\begin{bmatrix} A & B \\ B & C \end{bmatrix} = AC - B'}$.Then prove that a) If $\boldsymbol{\Delta > 0}$ and $\boldsymbol{A > 0, f}$ has a relative minimum at $\boldsymbol{a}$.b) If $\boldsymbol{\Delta > 0}$ and $\boldsymbol{A < 0, f}$ has a relative maximum at $\boldsymbol{a}$.c) If $\boldsymbol{\Delta < 0, f}$ has a saddle point at $\boldsymbol{a}$.

Part C

1. State and Prove Riesz-Fischer theorem.
2. State and prove mean-valued theorem for vector-valued functions.
3. Assume $\boldsymbol{f = (f_1, f_2, \ldots, f_n) \in C'}$ on an open set in $\boldsymbol{R^n}$, and let $\boldsymbol{T = f(S)}$.If the Jacobian determinant $\boldsymbol{J_r(a) \neq 0}$ for some point $\boldsymbol{a}$ in $\boldsymbol{S}$, then prove that there are two open sets $\boldsymbol{X \subseteq S}$ and $\boldsymbol{Y \subseteq T}$ and a uniquely determined function $\boldsymbol{g}$ such that
   a) $\boldsymbol{a \in X}$and$\boldsymbol{f(x) \in Y}$,
   b) $\boldsymbol{Y = f(X)}$,
   c) $\boldsymbol{f}$is one-to-one on $\boldsymbol{X}$,
   d) $\boldsymbol{g}$is defined on $\boldsymbol{Y, g(Y) = X}$ and $\boldsymbol{g\big(f(x)\big) = x}$ for every $\boldsymbol{x}$ in $\boldsymbol{X}$,
   e) $\boldsymbol{g \in C'}$on$\boldsymbol{Y}$.

Head of the Department | **Course Instructor**

Dr.T.Sheeba Helen | **Dr.M. K. Angel Jebitha**

Department : Mathematics

Class : I M. Sc Mathematics

Title of the Course : Partial Differential Equation

Semester : II

Course Code : MP232CC3

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP232CC3	**5**	1	-	-	**4**	**6**	**75**	**25**	**75**	**100**

Objectives

1.To formulate and solve different forms of partial differential equations.

2. Solve the related application-oriented problems.

Course Outcomes

On the successful completion of the course, students will be able to:		PSO Addressed	Cognitive Level
1.	recall the definitions of complete integral, particular integral, and singular integrals.	PSO-2	R
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
3.	analyze the classification of partial differential equations in three independent variables – Cauchy's problem for a second-order partial differential equation.	PSO-3	An
4.	solve the boundary value problem for the heat equations and the wave equation.	PSO-4	Ap

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	Module	Topic	Teaching Hours	Cognitive level	Pedagogy	Assessment/ Evaluation
I	**Non -linear partial differential equations of first order**					
	1.	Introduction	1	K3	Brainstorming	Questioning
	2.	Explanation of terms, compactible system of first order equations	3	K3	Heuristic Method	Recall Steps
	3.	Examples related to compactible system	3	K3	Blended Learning	Slip Test
	4.	Explaining Charpit's Method	2	K4	PPT	True or False
	5.	Example Problems related to charpit's method	2	K3	Interactive Method	Peer Discussion with questions
	6.	Solving problems using charpit's method	3	K3	Inductive Learning	Short Summary
II	**Homogeneous linear partial differential equation with constant coefficient**					
	7.	Homogeneous and non-homogeneous linear equation with constant coefficient	2	K2	Blended Learning	Questioning
	8.	Solution of finding homogeneous equation with constant coefficient, Theorem I, II	2	K2	Blended Learning	Proof Narrating
	9.	Method of finding complementary function	2	K3	Flipped Classroom	Short Answer
	10.	Working rule for finding complementary function, Alternative working rule for finding complementary	2	K3	Heuristic Method	MCQ

		function				
	11.	Examples for finding Complementary function	3	K3	Analytic Method	Recall Steps
	12.	General method and working rule for finding the particular integral of homogeneous equation and some example	2	K3	PPT	Relay Race
	13.	Examples to find the particular integral	2	K3	Brainstorming	Match the following
III	**Non – homogeneous linear partial differential equations with constant coefficient**					
	14.	Definition, Reducible and irreducible linear differential operators	3	K3	Brainstorming	Questioning
	15.	Reducible and irreducible linear partial differential equations with constant coefficient	2	K3	Interactive Method	Slip Test
	16.	Determination of complementary function	2	K2	PPT using Microsoft 365	True or False
	17.	General solution and particular integral of non-homogeneous equation and some examples of type 1	2	K2	Heuristic Method	Peer Discussion with questions
	18.	Examples of type 2	2	K2	Blended Learning	Creating Quiz with Group Discussion
	19.	Problems related to type 3	2	K5	Blended Learning	Relay Race
	20.	Examples related to type 4, Miscellaneous examples for the determination of particular integral	2	K2	Inductive Learning	Questioning
IV	**Classification of Partial Differential equations of second order**					
	21.	Classification of Partial Differential equations of second order	2	K1	Analytic Method	Quiz

	22.	Classification of P.D.E. in three independent variables	2	K2	Heuristic Method	MCQ – Slido
	23.	Cauchy's problem for a second order P.D.E.	2	K3	Flipped Classroom	Slip Test
	24.	Characteristic equation of the second order P.D.E	2	K4	Video using Zoom	Questioning
	25.	Characteristic curves of the second order P.D.E	1	K5	Analytic Method	Slip Test
	27.	Laplace transformation.	2	K4	Heuristic Method	True or False
	28.	Reduction to Canonical (or normal) forms.	2	K5	Flipped Classroom	Presentation
V	**Boundary Value Problem**					
	29.	A Boundary value problem, Solution by Separation of variables, Solution of one dimensional wave equation	2	K3	Brainstorming	Questioning
	30.	D'Alembert's solution, Solution of two dimensional wave equation	2	K3	Interactive Method	Slip Test
	31.	Vibration of a circular membrane, Examples related to vibration of a circular membrane	3	K4	PPT	True or False
	32.	Solution of one dimensional heat equation, Problems related to solution of one dimensional heat equation	2	K4	Heuristic Method	Peer Discussion with questions
	33.	Solution of two dimensional Laplace's equation	3	K4	Blended Learning	Group Discussion
	34.	Solution of two dimensional heat equation	3	K3	Analytic Method	MCQ

Course Focusing on Employability/ Entrepreneurship/ Skill Development: Skill Development

Activities (SD): Quiz, MCQ, Slip Test, Problem Solving, Presentation, Relay Race

Assignment: Find the solution of one dimensional wave equation

Sample questions

Part A

1.The system of two given PDE is compatible possess -----------

(a) no solution (b) Two solution (c) Infinitely many solutions (d) Unique solution

2.First order PDE are compatible iff -------------

3. If u is the C.F and z’ a P.I of a linear PDE then ------------is the general solution of the equation.

(a) u - z’ (b) u + z’ (c) u + z (d) u + f(z)

4. If $u_1, u_2, \ldots u_n$ are solution of the homogeneous linear PDE F(D, D’) z = 0 then -----------is also a solution, where $C_1, C_2, \ldots C_n$ are arbitrary constants.

5. A linear differential operator F (D, D’) is known as irreducible if -----------------.

6. Complementary function of the partial differential equation $(D^2 – D'^2 + D – D')\, z = 0$ is ---------------.

7. Classify the PDE 2r + 4s + 3t – 2 = 0.

8.The PDE $U_{xx} + U_{yy} + U_{zz} = 0$ is of-----------type.

(a) Hyperbolic (b) Parabolic (c) Elliptic (d) All the above

9. Give the eigen functions of one - dimensional wave equation.

10. What is the D’Alembert’s solution for wave equation.

Part-B

Answer all the questions:

11. Show that the equations xp =y q and z(xp + yq) = 2xyare compatible and solve them.

12. Find a complete integral of $q = yzp^2$.

13. Solve $(D - D')(D + D')z = (y+ 1)e^x$.

14. Solve $(D^2+2DD'+D'^2)z = 7 \cos y$.

15. Solve $(D^2 – DD' – 2D'^2 + 2D + 2D')z = \sin(2x + y)$.

16. Solve $D(D+D'-1)(D+3D'-2)z = x^2 - 4xy + 2y^2$.

17. Explain the classification of a PDE in three independent variables.

18. Find the characteristics of 4r + 5s + t + p + q – 2 = 0.

19. Find the General solution of one –dimensional wave equation $\frac{\partial^2 y}{\partial x^2} = \frac{1}{c^2}\left(\frac{\partial^2 y}{\partial t^2}\right)$.

20. Find the deflection u (x , y ,t) of the square membrane with a = b = 1 and c = 1, if the initial velocity is zero and show that the initial deflection is f (x, y) = A sin x sin 2xy.

Part-C

21. Solve completely the simultaneous equations: z = px + qy and 2xy $(p^2 + q^2)$ = z (yp + xq).

22. Find a complete integral of $(p^2 + q^2)^n$ (q x - p y) = 1.

23. Solve r – t = $\tan^3 x \tan y - \tan x \tan^3 y$.

24. Solve r + 2s + t = 2 cos y – x sin y.

25. Solve the PDE $(3D^2 - 2D'^2 + D - 1)z = e^{x+y} \cos(x+y)$.

26. Solve (D+D’) (D+ D’-2)z = sin (x +2y).

27. Reduce the equation yr + (x + y) s + xt = 0 to canonical form and hence find its

general solution.

28. Reduce the equation $\frac{\partial^2 z}{\partial x^2} + 2\frac{\partial^2 z}{\partial x \partial y} + \frac{\partial^2 z}{\partial y^2} = 0$ to canonical form and hence solve it.

29. A thin rectangular plane whose surface is impervious to heat flow has at t =0 an arbitrary distribution of temperature f(x,y). Its four edges x =0,x= a,y=0,y=b is kept at zero temperature. Determine the temperature at a point of the plate as t increases.

30. Find a temperature in a rod which is at a uniform temperature of 50 ^{0} C. Suddenly at t = 0, the end x =0 is cooled to 0 ^{0}C by an application of ice, and the end x= l is heated to 100 ^{0} C by an application of the stream,and these two-temperature s are maintained at ends. Furthermore, the rod is insulated along its length so that no transfer of heat can occur from the sides.

Head of the Department | **Course Instructor**

Dr. T. Sheeba Helen | **Dr. K. Jeya Daisy**

Department : Mathematics
Class : I M.Sc Mathematics
Title of the Course : Mathematical Statistics
Semester :II
Course Code: MP232EC1

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP232EC1	3	1	-	-	3	4	60	25	75	100

Learning Objectives

1. To enhance knowledge in mathematical statistics and acquire basic knowledge about various distributions.
2. To understand about mathematical expectations, moment generating function technique and the Central Limit Theorem.

Course Outcomes

CO	Upon completion of this course, the students will be able to:	PSO Addressed	Cognitive Level
1	recall the basic probability axioms, conditional probability, random variables and related concepts	PSO - 1	**K1**
2	learn the transformation technique for finding the p.d.f of functions of random variables and use these techniques to solve related problems	PSO - 3	**K2**
3	compute marginal and conditional distributions and check the stochastic independence	PSO - 4	**K3**
4	employ the relevant concepts of analysis to determine limiting distributions of random variables	PSO - 3	**K2**
5	design probability models to deal with real world problems andsolve problems involving probabilistic situations.	PSO – 2	**K3**

K1 - Remember; **K2** - Understand; **K3**– Apply

Total Contact Hours: 60 (Including lectures, assignments and tests)

Unit	Module	Topic	Teaching Hours	Cognitive level	Pedagogy	Assessment/ Evaluation
I	**Distributions of Functions of Random Variables**					
	1.	Sampling Theory	3	K_2(U)	Brainstorming	Questioning
	2.	Transformations of Variables of the Discrete Type	3	K_3(Ap)	Inductive Learning	Recall Steps
	3.	Transformations of Variables of the Continuous Type	3	K_3(Ap)	Blended Learning	Slip Test
	4.	The t and F Distributions	3	K_2(U)	Demonstration Method	Quiz - Quizzes
II	**Limiting Distributions**					
	1.	Limiting Distributions	3	K_2(U)	Brainstorming	Match the following – Gamma
	2.	Stochastic Convergence	3	K_3(Ap)	PPT using Gamma	Solve Problem
	3.	Limiting Moment Generating Functions	3	K_3(Ap)	Flipped Classroom	Group Discussion with questions
	4.	The Central Limit Theorem	3	K_2(U)	Heuristic Method	MCQ
III	**Estimation**					
	1.	Point Estimation	3	K_2(U)	Interactive Method	True or False
	2.	Measures of Quality of Estimators	2	K_3(Ap)	Heuristic Method	Peer Discussion with questions
	3.	Confidence Intervals for Means	2	K_3(Ap)	Blended Learning	Creating Quiz with Group Discussion
	4.	Confidence Interval for Difference of Means	3	K_2(U)	Blended Learning	Slip Test
	5	Confidence Interval for Variances	2	K_3(Ap)	Inductive Learning	Questioning
IV	**Statistical Hypothesis**					
	1.	Some Examples and Definitions	3	K_2(U)	Analytic Method	Peer Discussion with questions

	2.	Certain Best Tests	3	K_3(Ap)	Brainstorming	Quiz – Gamma
	3.	Uniformly Most Powerful Tests	3	K_3(Ap)	Inductive Learning	Slip Test
	4.	Likelihood Ratio Tests	3	K_2(U)	Blended Learning	Short Summary
V	**Other Statistical Tests**					
	1.	Chi-Square Tests	1	K_2(U)	Brainstorming	Match the following – Gamma
	2.	The Distributions of Certain Quadratic Forms	1	K_3(Ap)	PPT using Gamma	Solve Problem
	3.	A Test of Equality of Several Means	1	K_3(Ap)	Flipped Classroom	Short Answer – Google Form
	4.	Non central χ^2	1	K_2(U)	Heuristic Method	MCQ
	5	Non central F	2	K_3(Ap)	Flipped Classroom	Presentation

Course Focusing on Employability/ Entrepreneurship/ Skill Development: Skill Development

Activities (SD): Quiz, Slip Test, Problem Solving, presentation, Group Discussion and questions.

Assignment: Statistical Hypothesis

Seminar: Other Statistical Tests

Sample questions (minimum one question from each unit)

Part A

1. The variance of the random sample is defined as ---------
2. Give one example of random variables that have limiting distributions.
3. Define point estimation and give an example.
4. A test of a statistical hypothesis is a rule which, when the experimental sample values have been obtained, leads to a decision to accept or to reject the hypothesis under consideration.(Say True / False)
5. State the null hypothesis for a two-sample t-test.

Part B

1. Let the random variable X have the p.d.f f(x) = 1, o < x < 1= 0 elsewhere, Show that the random variable Y= -2 in X has a Chi square distribution with 2 degrees of freedom
2. Let $F_n(y)$ denote the distribution function of a random variable Y_n whose distribution depends upon the positive integer n. Let c denote a constant which does not depend upon n. The random

variable Y_n converges stochastically to the constant c if and only if, for every $\in > 0$, the lim Pr($|Yn - c| < \in$) = 1.

3. If we take n = 100 and y = 20, give the first approximate 95.4 per cent confidence interval
4. Let $X_l, X_2, ., ., X_n$ be a random sample from the normal distribution n(θ, 1). Show that the likelihood ratio principle for testing $H_o: \theta = \theta'$, where θ' is specified, against $H_1 : \theta \neq \theta'$ leads to the inequality $|\bar{x} - \theta| \geq c$. Is this a uniformly most powerful test of H_o against H_1
5. Show that the square of a non central T random variable is a non central F random variable.

Part C

1. Explain the t and F Distributions

2. State and prove the Central Limit Theorem

3. Describe the construction of a confidence interval for the mean of a normal distribution.

4. State and Prove the Neyman-Pearson Theorem.

5. Compute the mean of a random variable that has a non central F distribution with degrees of freedom r_1 and $r_2 > 2$ and non centrality parameter θ.

Head of the Department **Course Instructor**

Dr. T. Sheeba Helen **Dr. T. Sheeba Helen**

Department : Mathematics
Class : I M. Sc

Semester : II

Name of the Course : Operations Modeling

Course Code : MP232EC4

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP232EC4	3	1	-	-	3	4	60	25	75	100

Learning Objectives

1. To analyze different situations in the industrial/ business scenario involving limited resources
2. To finding the optimal solution within constraints.

Course Outcomes

CO	Upon completion of this course the students will be able to:	PSO addressed	
1	build and solve Transportation and Assignment problems using appropriate method	PSO – 2	K_1(R)
2	Learn the constructions of network and optimal scheduling using CPM and PERT	PSO - 3	K_2(U)
3	ability to construct linear integer programming models and solve linear integer programming models using branch and bound method	PSO - 3	K_5(E)
4	understand the need of inventory management.	PSO - 4	K_4(An)
5	To understand basic characteristic features of a queuing system and acquire skills in analyzing queuing models	PSO - 1	K_3(Ap)

Unit	Module	Topic	Teaching Hours	Cognitive level	Pedagogy	Assessment/ Evaluation
I	Transportation Models and its Variants					
	1.	Transportation Models and its Variants	2	K1 & K2	Brainstorming	MCQ
	2	Definition of the Transportation Model–	2	K3	Chalk and Talk	Slip Test using Socrative
	3	Non-Traditional Transportation Mode	3	K1 & K3	Analytic Method	Questioning
	4	Transportation Algorithm The Assignment Model	3	K5	Lecture with Illustration	slido
	5	Transportation Algorithm – The Assignment Model	2	K4	Collaborative learning	Q
II	Network Analysis					
	6	Network Analysis	1	K1	Seminar Presentation	True/False
	7	Minimal Spanning Tree Algorithm	1	K3	Seminar Presentation	Short summary of the theorem
	8	Shortest Route Problem	2	K2 & K3	Seminar Presentation	Concept definitions
	9	Maximum Flow Model	2	K3 & K4	Seminar Presentation	Recall steps
	10.	CPM –PERT	2	K3	Seminar Presentation	Questioning
III	Inventory Theory					
	11	Inventory Theory- Introduction	1	K1 & K2	Brainstorming	Quiz
	12	Basic Elements of an Inventory Model	2	K3	Lecture	Concept Explanation
	13	Deterministic Models	3	K4	Lecture Discussion	Slip Test
	14	Single Item Stock Model With And Without Price Breaks	3	K5	Lecture	Questioning
	15	Multiple Item Stock Model With And Without Price Breaks	3	K6	Collaborative learning	Questioning
IV	Probabilistic Models					

	16	Probabilistic Models: Continuous Review Model- Single Period Models.	3	K1 & K2	Brainstorming	Quiz
	17	Continuous Review Model	4	K3 & K4	Flipped Classroom	Differentiate between various ideas
	18	Single Period Models	4	K4 & K5	Analytic Method	Simple Questions
V	Queuing Theory					
	19	Queuing Theory-Introduction	2	K1 & K2	Seminar Presentation	MCQ
	20	Basic Elements of Queuing Model	2	K4	Seminar Presentation	Concept explanations
	21	Role of Poisson and Exponential Distributions	2	K4 & K5	Seminar Presentation	Questioning
	22	Pure Birth and Death Models	2	K2 & K3	Seminar Presentation	Slip Test
	23	Specialised Poisson Queues -(M/G/1):GD/∞/∞)	2	K2 & K5	Seminar Presentation	Simple Questions
	24	Pollaczek - Khintechine Formula	2	K4	Seminar Presentation	Evaluation through short test

Course Focussing on Employability/ Entrepreneurship/ Skill Development: **Employability**

Activities (Em/ En/SD): **Poster Presentation,**

Assignment: Problems based on Inventory and Queuing model. (Online)

Seminar Topic: unit II

Sample questions

Part A:

1. Which is known as Knapsack problem.

   a) Principle of optimality b) flyaway kit problem c) Cargo loading problem

2. Project scheduling by PERT-CPM consists of ___________ basic phases.

   a) 2 b) 3 c) 4 d) 5

3. An ___________ in a project is usually viewed as a job requiring time and resources for its

completion.

4. In a single server model(M/M/1): (GD/∞/∞), the W_q =---------------

5. The measure of L_s in machine servicing model is

a) $L_q + \frac{\lambda_{eff}}{\mu}$ b) $L_q + \lambda_{eff}$ c) $L_q + \mu \quad \lambda_{eff}$ d) $\mu + \lambda_{eff}$

Part B:

6. Find the optimal solution to the cargo loading problem.

7. Write the Formulation of CPM by linear programming approach.

8. Explain the factors which may also influence the way the inventory model is formulated.

9. Obtain the probability $P_n(t)$ of Departure Process.

10. Explain pure birth and death process.

Part - C

11. A Contractor needs to decide on the size of his work force over the next 5weeks.He estimates the minimum force size b_i for the 5 weeks to be 5,7,8,4 and 6 workers for i=1,2,3,4 and 5 respectively. Find the optimum sizes of the work force for the 5 – week planning horizon.

12. Given the following information

Activity	0-1	1-2	1-3	2-4	2-5	3-4	3-6	4-7	5-7	6-7
Duration	2	8	10	6	3	3	7	5	2	8

Draw the network diagram. Find critical path. Determine Total Float and free Float

13. Explain Single item static model.

14. Derive the difference- differential equations of(M/M/1): (GD/∞/∞).

15. Derive P.K formula

Head of the Department: **Course Instructor:**

Dr. T. Sheeba Helen **Dr. L. Jesmalar**

Department : **Mathematics**
Class : **I M.Sc.**
Title of the Course : **Modeling and Simulation with Excel**
Semester : **II**
Course Code : **MP232SE1**

Course Code	L	T	P	Credits	Inst. Hours	Total Hours	Marks		
							CIA	External	Total
MP232SE1	4	-	-	3	4	60	25	75	100

Objectives

- To know about modifying a spreadsheet and workbook
- To understand the concept of data analysis tools and data analysis for two data sets.

Course outcomes

CO	Upon completion of this course, the students will be able to:	PSO Addressed	Cognitive Level
CO - 1	Learn the spreadsheet and workbook.	PSO - 1	R
CO - 2	Understand the types of charts and graphs.	PSO - 2	U
CO - 3	Apply the custom data formats and layouts.	PSO - 3	Ap
CO - 4	Analyze the data with Excel.	PSO - 4	An
CO - 5	Create spreadsheets, workbooks and charts.	PSO - 5	C

Total Contact hours: 60 (Including lectures, assignments and tests)

Unit	Module	Topic	Teaching Hours	Cognitive level	Pedagogy	Assessment/ Evaluation
I	**Introduction to Spreadsheet Modeling**					
	1.	Feng Shui of Spreadsheets, Spreadsheet Makeover	3	K2	Introductory Session	Questioning
	2.	Julia’s Business Problem-A Very Uncertain Outcome, Ram’s Critique	2	K4	Narrative method	Short Summary
	3.	Julia’s New and Improved Workbook, Summary, Exercise	4	K3	Presentation	Problem Solving
II	**Presentation of Quantitative Data**					
	4.	Introduction, Data Classification	2	K2	Blended Learning	Concept Explain
	5.	Data Context and Data Orientation	2	K2	Interactive Lectures	Evaluation through Poll
	6.	Data Preparation Advice	3	K4	Flipped Classroom	Class Participation
III	**Data Visualization**					
	7.	Types of Charts and Graphs – Ribbons and the Excel Menu System, Some Frequently Used Charts	4	K2	Brainstorming	Questioning
	8.	Specific Steps for Creating a Chart, An Example of Graphical Data Analysis and Presentation, Example – Tere’s Budget for the 2nd Semester of college	4	K3	Interactive Method	Evaluation through short test
	9.	Collecting Data, Summarizing Data, Analyzing Data, Presenting Data, Summary, Exercise	3	K6	Group Discussion	Recall the methods
IV	**Analysis of Quantitative Data**					
	10.	Introduction, Data Analysis, Data Analysis Tools, Data Analysis for Two Data Sets	3	K2	Short Video	Quiz through Quizizz

	11.	Time Series Data: Visual Analysis, Cross-Sectional Data: Visual Analysis	3	K4	Lecture with Illustration	Online Assignment
	12.	Analysis of Time Series Data: Descriptive Statistics, Analysis of Cross-Sectional Data: Descriptive Statistics, Summary, Exercise	3	K4	Contextual Based Learning	Short Summary
V	**Presentation of Qualitative Data – Data Visualization**					
	13.	Introduction, Essentials of Effective Qualitative Data Presentation – Planning for Data Presentation and Preparation	3	K2	Lab Method	Practical
	14.	Data Entry and Manipulation – Tools for Data Entry and Accuracy, Data Transposition to Fit Excel	3	K3	Integrative Method	Presentation
	15.	Data Conversion with the Logical IF, Data Conversion of Text from Non-Excel Sources, Summary, Exercise	3	K5	Problem Solving	Class Test

Course Focussing on Employability/ Entrepreneurship/ Skill Development:Employability

Activities: Quiz, Slip test, Narrating Real Life Problems, Presentation

Assignment: Introduction to Spreadsheet Modeling, Presentation of Quantitative Data

Sample questions (minimum one question from each unit)

Part A

1. What is a hyperlink?

2. Data that have natural zero

a) ordinal data   b) interval data   c) ratio data   d) big data

3.The mother of all Graphs is the _______

4. Expand VBA

5. _______ is the tool of data menu that can be quite useful for promoting accurate data entry

Part B

1.Describe Ram's critique

2.Explain in detail about Data classification

3.List out the Specific Steps for creating a chart

4.What is Data Analysis?

5.Describe the Data Transposition to Fit Excel.

Part C

1.Explain in detail about Julia's New and Improved Workbook

2.Discuss about Data Preparation Advice

3. Describe about the types Of Chart and Graphs

4.Characterize about the Data Analysis Tools

5.Illustrate the Planning for Data Presentation And preparation

Head of the Department **Course Instructor**

Dr. T. Sheeba Helen **Sr. S. Antin Mary**

Department : **Mathematics**

Class : **II M.Sc Mathematics**

Title of the Course :**Complex Analysis**

Semester :**IV**

Course Code :**PM2041**

Course Code	**L**	**T**	**P**	**Credits**	**Inst. Hours**	**Total Hours**	**Marks**		
							CIA	**External**	**Total**
PM2041	**6**	**-**	**-**	**5**	**6**	**90**	**25**	**75**	**100**

Objectives

- To impart knowledge on complex functions
- To facilitate the study of advanced mathematics

Course outcomes

CO	**Upon completion of this course, the students will be able to:**	**PSO Addressed**	**Cognitive Level**
CO - 1	understand the fundamental concepts of complex variable theory	PSO - 1	U
CO - 2	effectively locate and use the information needed to prove theorems and establish mathematical results	PSO - 3	R
CO - 3	demonstrate the ability to integrate knowledge and ideas of complex differentiation and complex integration	PSO - 4	U
CO - 4	use appropriate techniques for solving related problems and for establishing theoretical results	PSO - 3	Ap
CO - 5	evaluate complicated real integrals through residue theorem	PSO – 2, 4	E
CO - 6	know the theory of conformal mappings which has many physical applications and analyse its concepts	PSO – 3, 4	An

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

Unit	Module	Topic	Teaching Hours	Cognitive level	Pedagogy	Assessment/ Evaluation
I	**Power Series**					
	1.	Abel's Theorem	2	K3	Brainstorming	Questioning
	2.	Abel's Limit Theorem	1	K3	Inductive Learning	Recall Steps
	3.	The Periodicity	2	K3	Blended Learning	Slip Test
	4.	Conformality	1	K4	PPT using nearpod	True or False
	5.	Arcs and Closed Curves	1	K3	Interactive Method	Peer Discussion with questions
	6.	Analytic Functions in a Regions	2	K3	Inductive Learning	Short Summary
	7.	Conformal Mapping, Length and Area	1	K4	Demonstration Method	Quiz - Quizzes
II	**Complex Integration**					
	8.	Cauchy's Theorem for a Rectangle	2	K2	Blended Learning	Proof Narrating
	9.	Cauchy's Theorem in a Disk	1	K2	Blended Learning	Proof Narrating
	10.	The index of a point with respect to a curve	3	K3	Flipped Classroom	Short Answer – Google Form
	11.	Cauchy's Integral formula	2	K3	Heuristic Method	MCQ
	12.	Higher Derivatives	2	K3	Derivative Method	Recall Steps
	13.	Removable Singularities, Taylor's Theorem	2	K3	PPT using Gamma	Relay Race
	14.	Zeros and Poles	2	K3	Brainstorming	Match the following – Gamma
III	**Complex Integration**					
	15.	The Local Mapping	2	K3	Brainstorming	Questioning
	16.	The Maximum Principle	2	K3	Interactive Method	Slip Test

	17.	Chains and Cycles	2	K2	PPT using Microsoft 365	True or False
	18.	Simple Connectivity	2	K2	Heuristic Method	Peer Discussion with questions
	19.	The General Statement of Cauchy's Theorem	2	K2	Blended Learning	Creating Quiz with Group Discussion
	20.	The Residue Theorem	2	K5	Blended Learning	Relay Race
	21.	The Argument Principle	2	K2	Inductive Learning	Proof Writing
	22.	Evaluation of Definite Integrals	5	K5	Problem Solving	Solve Problem
IV	**Series and Product Developments**					
	23.	Partial Fraction	2	K2	Video using Zoom	Quiz – Gamma
	24.	Infinite Products	2	K2	Video using Zoom	MCQ – Slido
	25.	Canonical Products	2	K2	Video using Zoom	Slip Test
	26.	The Gamma Function	2	K2	Video using Zoom	Short Summary
	27.	Jensen's Formula	1	K2	Analytic Method	Proof Narrating
	27.	Hadamard's Theorem	2	K2	Heuristic Method	Proof Narrating
	28.	The Riemann Zeta Function – The Product Development	2	K2	Flipped Classroom	Presentation
	29.	Extension of $\zeta(s)$ to the Whole Plane	2	K2	Flipped Classroom	Presentation
	30.	The Zeros of the Zeta Function	2	K2	Flipped Classroom	Presentation
	31.	Equicontinuity, Normality and Compactness	2	K2	Flipped Classroom	Presentation
	32.	Arzela's Theorem	2	K2	PPT	Proof Narrating
	33.	Families of Analytic Function	1	K2	Video using Zoom	Quiz - Socrative
	34.	The Classical Definition	1	K2	Video using Zoom	Slip Test
V	**Conformal Mapping**					

	35.	The Riemann Mapping Theorem	2	K3	Blended Learning	Proof Narrating
	36.	Boundary Behaviour, Use of the Reflection Principle	1	K3	Flipped Classroom	Presentation
	37.	Conformal Mapping of Polygons – Behaviour at an Angle	1	K4	Flipped Classroom	Presentation
	38.	The Schwarz-Christoffel formula	1	K3	Flipped Classroom	Presentation
	39.	Mappings on a Rectangle	1	K4	Flipped Classroom	Presentation
	40.	Harmonic Functions – Functions with the Mean Value Property, Harnack's Principle	2	K3	Flipped Classroom	Presentation

Course Focussing on Employability/ Entrepreneurship/ Skill Development: Skill Development

Activities (SD): Quiz, MCQ, Slip Test, Problem Solving, Proof Narrating, Presentation, Relay Race, Riddles

Assignment: Evaluation of Definite Integrals, The Riemann Zeta Function, Conformal Mapping

Sample questions (minimum one question from each unit)

Part A

Unit I

1. Say True or False: Any analytic function can be represented as a power series
2. When will we say that a function f(z) is a periodic function?
   (i)$f(z+c)=f(z)$ for all z (ii)$(z+c)=f(c)$ for all z
   (iii)$(z+c)=f(-z)$ for all z (iv)$(z+c)=f(c)$ for all c
3. Which of the following are correct?
   (a) An arc is the image of a closed finite interval under a mapping
   (b) An arc is the set of points (x, y) such that x=x(t), y=y(t), $\alpha<t\leq\beta$
   (c) An arc is the set of points (x, y) such that x=x(t), y=y(t), $\alpha\leq t\leq\beta$
   (i) (a) only (ii) (a) and (b) (iii) (a) and (c) (iv) (b) and (c)
4. Which of the following functions is a single valued function?
   (i)$f(z)=z$ (ii)$f(z)=z^2$ (iii)$f(z)=\log z$ (iv)$f(z)=\sqrt{z}$
5. An analytic function is said to be degenerates if it reduces to ....

Unit II

1. The winding number of a point inside the circle is
   (i) 1 (ii) 0 (iii) ∞ (iv) None of these
2. The value of Cauchy's Estimate is …….
3. Consider the function $f(z)=z^2$. Which of the following are true?
   (i) f is conformal at all points (ii) f is differentiable
   (iii) f is analytic (iv) f is continuous
4. True or False: Let x, y be zeros of an analytic function. Then there exist an neighbourhood which contains both x and y
5. The value of the integral $\int_\gamma \frac{dz}{z-a}$ if γ is a piecewise differentiable curve and does not pass through the point a

Unit III

1. If $f(z)$ is analytic and non-constant in a region Ω , then which value of$f(z)$ has no maximum in Ω?
2. The maximum value of modulus of $f(z)$ attains in ……………
3. Define Simply Connected Region
4. The value of $\int_0^\pi \log sinz\, dz$
   (i) $\pi \log 2$ (ii) $-\pi \log 2$ (iii) $\log 2$ (iv) $-\log 2$
5. If $f(z)$is analytic in a region Ω, then $\int_\gamma f(z)dz = 0$ for every cycle γ which is homologous to zero in Ω. This statement is known as …………

Unit IV

1. Write the two standard representation of rational function
2. Genus of the function $\sin \pi z$ is
   (i) 0 (ii) 1 (iii) 2 (iv) 3

3. If $\lim_{n\to\infty} P_n = 0$, then the infinite product $\prod_{n=1}^{\infty} Pn$ is ………..
4. True or False: A function which is analytic in the whole plane is said to be an Entire Function
5. Give an example of integral function which are not polynomial

Unit V

1. The polynomial is ……. if and only if all $\beta_k > 0$.
   (i) Concave (ii) Convex (iii) Analytic (iv) Empty
2. True or False: Every harmonic function satisfies the mean value condition
3. Define univalent function

4. Any two regions can be mapped ……… onto each other
5. Define Harnack's inequality

Part B

Unit I

1. Let f be an analytic function defined in a region Ω and $z_0 \epsilon \Omega$. If $f'(z_0) \neq 0$, then f is conformal at z_0
2. Define Jordan Curve, Piecewise Differentiable, Single and Multiple valued function with an example
3. If $\sum a_n z^n$ has radius of convergence R, what is the radius of convergence of $\sum a_n z^{2n}$ and $\sum {a_n}^2 z^n$.
4. Prove that an analytic function in a region Ω whose either derivative vanishes identically or the real part, the imaginary part, the modulus or the argument is constant must reduce to a constant
5. Find the single valued and analytic branch of the function $\sqrt{z}$ in Ω, where Ω is the complement of the negative real axis

Unit II

1. If the piecewise differentiable closed curve γ does not pass through the point a, then the value of the integral $\int_\gamma \frac{dz}{z-a}$ is a multiple of $2\pi i$
2. (i). If γ lies inside a circle, then $n(\gamma, a) = 0$ for all points a outside the circle
(ii). If a is a point inside the circle C, then $n(\gamma, a) = 1$
3. State and prove Liouville's Theorem
4. An analytic function comes arbitrary close to any complex value in every neighbourhood of an essential singularity
5. Let z_1 and $z_2$be two points on a closed curve γ which does not pass through the origin. Denote the subarc fromz_1 toz_2 in the direction of the curve γ_1 and the subarc from z_2 to $z_1$byγ_2. Suppose that z_1 lies in the lower half plane and z_2 lies in the upper half plane. If γ_1 does not meet the negative real axis and γ_2 does not meet the positive real axis, then $n(\gamma, 0) = 1$

Unit III

1. State and prove Schwarz Lemma
2. State and prove Argument Principle
3. Evaluate $\int_0^{2\pi} \frac{1}{a+cos\theta} d\theta, a > 1$.
4. Evaluate $\int_0^{\infty} \frac{x^2-x+2}{x^4+10x^2+9} dx$.
5. If $f(z)$ is defined and continuous on a closed bounded set E and analytic on the interior of E, then the maximum of $|f(z)|$ on E is assumed on the boundary of E

Unit IV

1. Find the expansion of $\pi\ cot\pi z$ by MittagLeffler Theorem
2. Show that $sin\pi z$ is an entire function of genus 1
3. Prove that the ξ –function can be extended to a meromorphic function in the whole plane whose only pole is a simple pole at s = 1 with the residue 1
4. Prove that a locally bounded family of analytic functions has locally bounded derivatives
5. The family $\mathfrak{F}$ is totally bounded if and only if to every compact set E⊂ Ω and every $\varepsilon > 0$ it is possible to find $f_1, \dots \dots, f_n \epsilon\ \mathfrak{F}$ such that every f$\epsilon\ \mathfrak{F}$satisfies d $(f, f_j) < \epsilon$ on E for some f_j

Unit V

1. If the boundary of Ω contains a free one-side analytic arc γ , then prove that the mapping function has an analytic extension to $\Omega \cup \gamma$ and γ is mapped on an arc of the unit circle.
2. Explain the functions with the mean value property
3. Prove that a continuous function u(z) which satisfies condition u (z_o)= $\frac{1}{2\pi}\int_0^{2\pi} u(z_o + re^{i\theta})d\theta$ is necessarily harmonic
4. State and prove Harnack's inequality

Part C

Unit I

1. State and prove Abel's Theorem
2. State and prove Abel's Limit Theorem
3. Prove that every period of e^{iz} is an integral multiple of its smallest period
4. Find the single-valued and analytic branch of the function $log\ z$ in Ω, where Ω is the complement of the negative real axis $z \leq 0$

Unit II

1. State and prove Cauchy's Theorem for Rectangle
2. State and prove generalization of Cauchy's Theorem in a disk
3. Let $f(z)$ be analytic in an open disk Δ and γ be a closed curve in Δ. Then for any point a not on γ, $n(\gamma, a). f(a) = \frac{1}{2\pi i}\int_\gamma \frac{f(z)}{z-a}dz$, where $n(\gamma, a)$ is the index of a with respect to γ. Also derive the Cauchy's Integral Formula.
4. If $f(z)$ is an analytic function such that $f(z)$ and all of its derivatives vanishes at a point a in a region Ω, then $f(z)$ vanishes identically in Ω.
5. State and prove Taylor's Theorem

Unit III

1. Let $f(z)$ be analytic except for isolated singularities a_j in a region Ω. Then $\frac{1}{2\pi i}\int_{\gamma} f(z)dz = \sum_j n(\gamma, a_j) Res_{z=a_j} f(z)$ for any cycle γ which is homologous to zero in Ω and does not pass through any one of the points a_j
2. A region Ω is simply connected if and only if $n(\gamma, a) = 0$ for all cycles γ in Ω and all points a which do not belong to Ω
3. Evaluate $\int_0^{\pi} \log sinx \ dx$.
4. (i). Evaluate $\int_0^{\infty} \frac{x^{\frac{1}{3}}}{1+x^2} dx$

   (ii). Evaluate $\int_0^{\infty} \frac{x \, sinx}{x^2+a^2} dx$

   (iii).Evaluate $\int_0^{\infty} \frac{sinx}{x} dx$
5. State and prove Characterization theorem

Unit IV

1. The infinite product $\prod_{n=1}^{\infty}(1 + a_n)$ with $(1 + a_n) \neq 0$ converges simultaneously with the series $\sum_1^{\infty} \log(1 + a_n)$ whose terms represent the values of the principal branch of the logarithm
2. Suppose $f(z)$ is holomorphic function with $f(0)$ is non-zero and $f(z)$ has zero at $a_1, a_2, \dots, a_n$ inside $|z| < \rho$. Then $\log|f(0)| = -\sum_{k=1}^{n} \log\left(\frac{\rho}{|a_k|}\right) + \frac{1}{2\pi}\int_0^{2\pi} \log|f(\rho e^{i\theta})| \, d\theta$.
3. Prove that $\frac{\pi^2}{\sin^2 \pi z} = \sum_{-\infty}^{\infty} \frac{1}{(z-n)^2}$
4. Prove that a family $\mathfrak{I}$ of analytic functions is normal with respect to C if and only if the functions in $\mathfrak{I}$ are uniformly bounded on every compact set
5. State and prove Arzela's Theorem

Unit V

1. State and prove Schwartz – Christoffel Formula
2. State and prove Riemann Mapping theorem
3. State and prove Harnack's Principle
4. Show that the inverse function of the elliptic integral $\int_0^{\omega} \frac{d\omega}{\sqrt{(1-\omega^2)(1-k^2\omega^2}}$ is a meromorphic function with periods 2k and 2ik

Head of the Department | **Course Instructor**

Dr. T. Sheeba Helen | **Dr. A. Anat Jaslin Jini**

Department : **Mathematics**
Class : **II M.Sc Mathematics**
Title of the Course : **Functional Analysis**
Semester : **IV**

Course Code : **PM2042**

Course Code	L	T	P	Credits	Inst. Hours	Total Hours	Marks		
							CIA	External	Total
PM2033	6	-	-	5	6	90	25	75	100

Objectives

1. To study the three structure theorems of Functional Analysis and to introduce Hilber Spaces and Operator theory.
2. To enable the students to pursue research.

Course outcomes

CO	Upon completion of this course, the students will be able to:	PSO addressed	Cognitive level
CO - 1	Learn and understand the definition of linear space , normed linear space, Banach Space and their examples	PSO - 1	K1(R)
CO - 2	Explain the concept of different properties of Banach Spaces, Hahn Banach theorem	PSO -2	K2(U)
CO - 3	Compare different types of operators and their properties, Natural imbedding	PSO - 2	K3(Ap)
CO - 4	Explain the ideas needed for open mapping theorem , Open Mapping theorem	PSO - 1	K5(C)
CO - 5	Construct the idea of projections , the spectrum of an operator and develop problem solving skills , Matrices, Determinants	PSO - 1	K3(Ap)
CO - 6	Learn and understand the definition of Hilbert Spaces ,Orthogonal Complements	PSO - 4	K1(R)
CO - 7	Explain the concept of the adjoint of an operator, Normal and Unitary operators, Spectral Theory	PSO - 2	K4(An)

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

Unit	Module	Topic	Teaching Hours	Cognitive level	Pedagogy	Assessment/ Evaluation
I	**Banach spaces**					
	1.	Banach spaces	4	K2(U)	Lecture with Illustration	Evaluation through slido,MCQ
	2.	Definition and examples	2	K1(R)	Blended classroom	Simple definitions, MCQ, Recall steps, Concept definitions
	3.	Continuous linear transformations	4	K2(U)	Flipped Classroom	SlipTestusing Quizziz
	4.	The Hahn Banach theorem.	5	K4(An)	Integrative method	Evaluation through short test, Seminar
II	**The natural imbedding of N into N****					
	1.	The natural imbedding of N into N**	5	K1(R)	Group Discussion	Questioning
	2.	The open mapping theorem	5	K2(U)	Integrative method	Evaluation through slido
	3.	The conjugate of an operator.	5	K4(An)	Peer Instruction	SlipTestusing Quizziz
III	**Hilbert spaces**					
	1.	Hilbert spaces	4	K1(R)	Brainstorming	Quiz
	2.	Definition and properties	4	K3(Ap)	Lecture	Concept Explanation
	3.	Orthogonal complements - Orthonormal sets	4	K3(Ap)	Lecture Discussion	SlipTest
	4.	The conjugate space	3	K5(C)	Lecture	Evaluation through quiz test using quizziz
IV	**Adjoint of an operator**					
	1.	Adjoint of an operator, self adjoint operators	3	K2(U)	Lecture,Introductory session	Evaluation through quiz test using quizziz, Seminar, MCQ, Recall steps
	2.	Normal and unitary operators	3	K1(R)	Group Discussion	Questioning

	3.	Projections	3	K3(Ap)	Lecture with Illustration	Evaluation through slido,MCQ
	4.	Spectral theory - Spectrum of an operator	3	K4(An)	Blended classroom	Simple definitions, MCQ, Recall steps, Concept definitions
	5.	The spectral theorem	3	K2(U)	Flipped Classroom	SlipTestusing Quizziz
V	**Banach Algebras**					
	1.	Banach Algebras: The definition and some examples	5	K2(U)	Seminar Presentation	MCQ
	2.	Regular and singular elements	3	K2(U)	Seminar Presentation	Concept explanations
	3.	The spectrum	3	K4(An)	Seminar Presentation	Questioning
	4.	The formula for the spectral radius	4	K3(Ap)	Seminar Presentation	SlipTest

Course Focussing on Skill Development

Activities (Em/ En/SD):Evaluation through Quiz Competition

Assignment :Adjoint of an operator(PPT)

Seminar Topic: Banach Algebras

Sample questions

Part A

1. Let x, y be elements of a Hilbert space H, such that $\| x \| = 3$, $\| y \| = 4$ and $\| x+y \| = 7$.Then $\| x-y \|$ equals:

   (a) 1 (b) 2 (c) 3 (d) $\sqrt{2}$

2. Choose the correct answer for the following norm $\|\square^*\square\| =$

   (a) $\|\square^*\|\|\square\|$ (b) $\|\square\|^2$ (c) $\|\square^*\|^2$ (d) $\|\square^2\|$.

3. The weak * topology is weaker than the ....topology.

4. Say True or False

The Hilbert cube is compact as a subspace of l_2

5. $(T_1 T_2)^* =$………..

Part B

1. State and prove Holder's inequality.
2. State and prove the Closed theorem.
3. State and prove the Schwartz inequality.
4. Show that a closed linear subspace M of H is invariant under an operator $T \Leftrightarrow M^{\perp}$ is invariant under T*.
5. Show that if T is normal then each $M_i$reduces T.

Part C

1. State and prove the Hahn Banach Theorem.
2. Show that a closed convex subset C of a Hilbert space H contains a unique vector of smallest norm.
3. State and prove the open mapping theorem.
4. If T is an operator on H for which <Tx, x> = 0. For all x, prove that T = 0.
5. State and prove the spectral theorem.

Head of the Department

Dr.T.Sheeba Helen

Course Instructor

Dr. A. Jancy Vini

Department : **Mathematics**
Class : **II M Sc**
Semester : **IV**
Name of the Course : **Operations Research**
Course code : **PM2043**

Course Code	L	T	P	Credits	Inst. Hours	Total Hours	Marks		
							CIA	External	Total
PM2034	**6**	**-**	**-**	**5**	**6**	**90**	**25**	**75**	**100**

Objectives: 1. To learn optimizing objective functions.

2. To solve real life-oriented decision-making problems.

Course Outcome

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	explain the fundamental concept of DP model, Inventory model and Queuing model	PSO - 2	K_1(R)
CO - 2	relate the concepts of Arrow (Network)diagram representations, in critical path calculations and construction of the Time chart	PSO - 3	K_2(U)
CO - 3	distinguish deterministic model and single item	PSO - 3	K_5(E)
CO - 4	interpret Poisson and Exponential distributions and apply these concepts in Queuing models	PSO - 4	K_4(An)
CO - 5	Solve real life- oriented decision-making problems by optimizing the objective function	PSO - 1	K_3(Ap)

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

Unit	Section	Topics	Lecture hours	Cognitive level	Pedagogy	Assessment / Evaluation
I		**Elements of DP model**				
	1	Elements of the DP Model, The Capital Budgeting Example	4	K_2(U)	Introductory session, Group Discussion, PPT.	Slip Test Simple definitions, Recall steps Evaluation through Quizzes,MCQ, True/False. Evaluation through Nearpod. Assignment
	2	More on the definition of the state	3	K_1(R)	Lecture using Chalk and talk, Problem-solving, Group Discussion.	
	3	Examples of DP models and computation	3	K_2(U)	Lecture using Chalk and talk, Problem-solving, Group Discussion.	
	4	Solution of linear programming by dynamic programming	2	K_4(An)	Problem-solving, Demonstration.	
	5	Game theory	3	K_3(Ap)	Lecture using Chalk and talk, Problem-solving, Group Discussion.	
II		**Arrow (Network) Diagram**				
	1	Introduction Arrow (Network), Diagram Representations	3	K_2(U)	Group Peer tutoring.	Short Test Formative assessment I, Evaluation through short tests.
	2	Critical Path Calculations, Problem based on critical Path Calculations, Determination of floats	4	K_4(An)	Lecture using Chalk and talk, Problem-solving, Group Discussion.	
	3	Construction of the	4	K_3(Ap)	Problem-solving, Group	

		Time Chart and Resource Leveling, Problems based on Time Chart and Resource Leveling			Peer tutoring.	Seminar on Arrow (Network) Diagram Quizzes
	4	Probability and Cost Considerations in Project Scheduling.	2	K_3(Ap)	Lecture with discussion	
III		**Generalized Inventory model**				
	1	Introduction, Generalized Inventory model, Types of Inventory Models	4	K_2(U)	Lectures using videos.	Slip Test, Online Quiz Formative assessment II Seminar on Generalized Inventory model Evaluation through short tests, Seminar. Evaluation through Seminar.
	2	Deterministic Models, Single Item Static Model, Problems based on Single Item Static Model	4	K_4(An)	Introductory session, Group Discussion.	
	3	Single Item Static, Model with Price Breaks, Problems based on Single Item Static Model with Price Breaks	3	K_4(An)	PPT, Review	
	4	Multiple - Item static Model with Storage Limitations, Problems based on Multiple - Item static Model with Storage Limitations	2	K_3(Ap)	Lecture with PPT illustration	
	5	Single – Item static Model with Storage Limitations.	2	K_3(Ap)	Lecture with Group discussion.	
IV		**Queuing Model**				
	1	Basic Elements of the Queuing Model, Roles of Poisson Distributions, Roles of Exponential	3	K_1(R)	Peer tutoring, Lectures using videos.	Short Test

		Distributions				MCQ, True/False.
	2	Arrival process, Examples of arrival process	2	K_2(U)	Problem-solving, Group Discussion.	Concept definitions, Seminar.
	3	Departure process, Queue with Combined Arrivals and Departure	3	K_4(An)	Lecture using Chalk and talk, Problem-solving, Group Discussion.	Seminar.
	4	Problems based on Queue with Combined Arrivals and Departure	2	K_3(Ap)	Problem-solving, PPT.	Concept definitions, Seminar.
	5	Queuing Models of Type: (M/M/1): (GD/∞/∞), Problems based on: (M/M/1): (GD/∞/∞)	3	K_3(Ap)	Problem-solving, Group Discussion.	Concept definitions, Seminar.
	6	Queuing Models of Type (M/M/1): (GD/N/∞), Problems based on (M/M/1): (GD/N/∞)	3	K_3(Ap)	Problem-solving, Group Discussion.	
V		**Types of Queuing Models**				
	1	Queuing Model (M/G/1): (GD/∞/∞), (M/M/C) : (GD/∞/∞), The Pollaczek-Khintchine Formula	4	K_2(U)	Problem-solving, PPT.	Short Test
	2	Problems based on(M/M/C): (GD/∞/∞), (M/M/∞): (GD/∞/∞) Self service Model	4	K_3(Ap)	Problem-solving, Group Discussion.	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	K_3(Ap)	Lecture using Chalk and talk, Problem-solving, Group Discussion.	Concept definitions
	4	Tandem or series queues	3	K_4(An)	Lecture using Chalk and talk, Problem-solving, Group Discussion.	Concept definitions

Course Focusing on Employability/ Entrepreneurship/ Skill Development: Skill Development

Activities (SD): Quiz, Problem Solving

Assignment: Problems based on Queue with Combined Arrivals and Departure. (Online)

Seminar Topic: Probability and Cost Considerations in Project Scheduling.

Sample questions (minimum one question from each unit)

Part A:

1.Which is known as Knapsack problem.

a) Principle of optimality b) flyaway kit problem c) Cargo loading problem

2.Project scheduling by PERT-CPM consists of __________ basic phases.

a) 2 b) 3 c) 4 d) 5

3.An __________ in a project is usually viewed as a job requiring time and resources for its completion.

4.In a single server model(M/M/1): (GD/∞/∞), theW_q =---------------

5.The measure of L_s in machine servicing model is

a)$L_q + \frac{\lambda_{eff}}{\mu}$ b) $L_q + \lambda_{eff}$ c) $L_q + \mu \lambda_{eff}$ d) $\mu + \lambda_{eff}$

Part B:

6.Find the optimal solution to the cargo loading problem. Consider the following special case of three items and assume thatW=5.

i	w_i	v_i
1	2	65
2	3	80
3	1	30

7.Write the Formulation of CPM by linear programming approach.

8.Explain the factors which may also influence the way the inventory

model isformulated.
9.Obtain the probability P_n(t) of Departure Process**.**
10. Explain (M/M/R): (GD/K/K) machine service model.

Part - C

11.A Contractor needs to decide on the size of his work force over the next 5weeks.He estimates the minimum force size $b_i$for the 5 weeks to be 5,7,8,4 and 6 workers for i=1,2,3,4 and 5 respectively. Find the optimum sizes of the work force for the 5 – week planning horizon.
12.Given the following information

Activity	0-1	1-2	1-3	2-4	2-5	3-4	3-6	4-7	5-7	6-7
Duration	2	8	10	6	3	3	7	5	2	8

Draw the network diagram. Find critical path. Determine Total Float and free Float

13.Explain Single item static model.

14.Derive the difference- differential equations of(M/M/1): (GD/∞/∞).

15**.**Derive the difference- differential equations of(M/M/∞): (GD/∞/∞).

Head of the Department **Course Instructor**

Dr. T. Sheeba Helen **Mrs. J C Mahizha**

:

Department : Mathematics
Class : II M. Sc
Title of the Course : Algorithmic Graph Theory

Semester : IV
Course Code : PM2044

Course Code	L	T	P	Credits	Inst. Hours	Total Hours	Marks		
							CIA	External	Total
PM2044	6	-	-	4	6	90	25	75	100

Learning Objectives:

1. To instil knowledge about algorithms.

2. To write innovative algorithms for graph theoretical problems.

Course Outcomes

CO	Upon completion of this course the students will be able to:	PSO addressed	Cognitive level
CO - 1	understand basic algorithms and write algorithms for simple computing.	PSO - 1	K2(U) E
CO - 2	analyze the efficiency of the algorithm.	PSO - 2	K4(An)
CO - 3	understand and analyze algorithmic techniques to study basic parameters and properties of graphs.	PSO - 2	K1(R) K4(An)
CO - 4	use effectively techniques from graph theory, to solve practical problems in networking and communication.	PSO - 3	K3(Ap)

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

Unit	Module	Topics	Teaching Hours	Cognitive level	Pedagogy	Assessment/ Evaluation
I	**The Role of Algorithms in Computing and Getting Started**					
	1	Role of algorithms in computing- Algorithms,	4	K1 & K2	Lecture with illustration	Concept Explanation

		Data structures, Technique, Hard problems, Parallelism				
	2	Algorithms as a technology- Efficiency, Algorithms and other technologies	2	K4	Flipped Classroom	Questioning
	3	Insertion sort and its algorithm, Pseudocode conventions	3	K2	Lecture with PPT illustration	Evaluation through MCQ
	4	Analyzing Algorithms- Worst-case and average-case analysis	3	K2 & K3	Interactive Lectures	SlipTest
	5	Designing Algorithms - The divide-and-conquer approach and its algorithm, Analysis of merge Sort	3	K2 & K4	Gamification	Self-assessment
II	**Elementary Graph Algorithms**					
	1	Representation of graphs – adjacency list representation, adjacency matrix representation	3	K1 & K2	Lecture with illustration	Evaluation through short test
	2	Definitions and Breadth first Search algorithms, Shortest paths and related Lemmas, Corollary and	3	K2	Lecture with PPT illustration	Class Participation

		correctness of Breadth first Search theorem				
	3	Breadth-first trees, related Lemma, Definitions and Depth first search algorithms	3	K2 & K3	Integrative method	Quiz (slido)
	4	Parenthesis theorem, Corollary on nesting of descendant's intervals, White-path theorem	3	K2	Group Discussion	Questioning
	5	Topological Sort, Strongly Connected Components and related Lemmas and Theorems	4	K4	Flipped Classroom	Concept Explanation
III	**Growing a minimum spanning tree and The algorithms of Kruskal and Prim**					
	1	Theorem, Corollary related to Growing a minimum spanning tree	3	K2	Lecture with illustration	Assignment on minimum spanning tree
	2	Kruskal's algorithm	3	K1 & K3	Collaborative learning	Evaluation through MCQ (Quizziz)
	3	Prim's algorithm, The execution of Prim's algorithm on the graph	4	K4	Group Discussion	Self-assessment
	4	Problems based on minimum	3	K3	Gamification	Questioning

		spanning tree				
IV	**The Bellman – Ford algorithm and Dijkstra's algorithm**					
	1	Lemma and Corollary based on correctness of the Bellman-Ford algorithm	3	K3	Lecture with PPT illustration	Short Test
	2	Theorem and definition related to Single-source shortest paths in directed acyclic graphs	3	K1 & K3	Integrative method	SlipTest
	3	Dijkstra's algorithm, The execution of Dijkstra's algorithm	3	K2 & K4	Group Discussion	Questioning
	4	Corollary and analysis of Dijkstra's algorithm	4	K4	Flipped Classroom	MCQ (Google forms)
	5	Difference Constraints and Shortest Paths- Systems of Difference Constraints, Constraint graphs, Solving Systems of Difference Constraints	3	K3	Collaborative learning	Slip Test
V	**Shortest Paths and Matrix multiplication, The Floyd-Warshall algorithm**					
	1	Computing the shortest-path weights bottom up algorithm	3	K1 &K3	Seminar Presentation	Short Test
	2	Algorithm for matrix multiplication, Improving the	3	K4	Seminar Presentation	Evaluation through Quiz (slido)

		running time and technique of repeated squaring				
	3	The structure of a shortest path, A recursive solution to the all-pairs shortest paths problem	3	K3	Seminar Presentation	MCQ
	4	Computing the shortest-path weights bottom up algorithm, Transitive closure of a directed graph algorithm	4	K2 & K3	Seminar Presentation	Questioning
	5	Johnson's Algorithm for Sparse Graphs-Preserving shortest paths by reweighting and related Lemma	2	K2	Seminar Presentation	SlipTestusing Quizziz

Course Focusing on Employability/ Entrepreneurship/ Skill Development: Employability

Activities (Em/ En/SD): Poster Presentation, Group Discussion

Assignment: Apply DFS to detect cycles in a directed graph.

Seminar Topic:Shortest Paths and Matrix multiplication, The Floyd-Warshall algorithm

Sample questions

Part – A

1.Complete: An algorithm is said to be ………… if for every input instance it halts with the correct output.

a) exact b) correct c) incorrect d) perfect

2. What isthe total running time of the BFS algorithm?

a) $\Theta(V+E)$ b) $\Theta(n \lg n)$ c) cn^2 d) cn

3. Say true or false.

Kruskal's algorithm is similar to the connected components algorithm.

4. Choose: A system of difference constraints with m constraints on n unknowns produces a graph with $n+1$ vertices and ……… edges.

a) m b) n c) n-m d) n+m

5. What is the intermediate vertex of a simple path $p = \langle v_1, v_2, v_3, \dots, v_l \rangle$

Part – B

1. Write a short note on RAM model.

2. Prove that a directed graph *G* is acyclic if and only if a depth-first search of *G* yields noback edges.

3. Write MST-KRUSKAL(G,w) algorithm.

4. Explain the system of difference constraints.

5. Write square matrix multiplication algorithm.

Part – C

1.Describe about pseudocode conventions.

2. State and prove white path theorem.

3. Explain Prim's algorithm with an illustration.

4. Define Bellman-Ford algorithm. State and prove correctness of the algorithm.

5. Prove that reweighting does not change shortest paths.

Head of the Department **Course Instructor**

Dr. T. Sheeba Helen **Dr. V. Sujin Flower**

Department : **Mathematics**

Class : **II M.Sc**

Semester : **IV**

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

Unit	Module	Topic	Teaching Hours	Cognitive level	Pedagogy	Assessment/ Evaluation
I						
	1.	Permutations and combinations	3	K1(R)	Introductory session, Brain Storming	Simple definitions, MCQ, Recall formulae
	2.	The Rules of Sum and Product	4	K2(U)	Lecture using videos, Problem solving, PPT	Quiz through Quizziz, MCQ, Recall formulae
	3.	Distribution of distinct objects	4	K4(An)	Group Discussion	Suggest formulae, Solve problems, Home work
	4.	Distribution of non-distinct objects	4	K4(An)	Lecture using Chalk and talk, Problem solving, PPT	Class test, Problem solving questions, Home work
II						
	1.	Generating functions	3	K1(R), K2(U)	Blended Classroom	Simple definitions, MCQ, Recall formulae
	2.	Generating functions for combinations	3	K3(Ap), K2(U)	Lecture using Chalk and talk, Problem solving	Problem solving, Home work
	3.	Enumerators for Permutations.	2	K2(U)	Flipped Classroom	Home work
	4.	Distribution of distinct objects into nondistinct cells	3	K3(Ap)	Collaborative Learning	Slip test, Assignments
	5.	Partitions of integers	2	K3(Ap)	Lecture using Chalk and talk, Problem solving	Class Test, Problem solving
		The Ferrers graph	2	K2(U)	Peer Teaching	Brain Storming
III						
		Recurrence Relations	5	K3(Ap), K2(U)	Seminar Presentation	Evaluation through Nearpod
		Linear Recurrence Relations with	5	K2(U)	Seminar Presentation	Quiz

		Constant Coefficients				
		Solution by the Technique of Generating Functions	5	K3(Ap)	Seminar Presentation	Assignment
IV						
		The Principle of Inclusion and Exclusion	3	K2(U)		Brain Storming
		The General Formula	3	K2(U)	Lecture using Chalk and talk, Problem solving, Peer tutoring	Brain Storming, Problem solving
		Derangements	3	K2(U)	Seminar Presentation	Slip test, Quiz through Quizziz
		Permutations with Restrictions on Relative Positions	3	K2(U)	Seminar Presentation	Simple Questions
		The Rook Polynomials	3	K3(Ap), K4(An)	Flipped Classroom	Brain Storming, Problem solving
V						
		Polya's Theory of Counting	3	K2(U)		Class test
		Equivalence Classes under a Permutation Group	3	K2(U)	Blended Classroom	Problem solving, Home work
		Equivalence classes of Function	3	K3(Ap)	Lecture using Chalk and talk	Slip test, Assignments
		Weights and Inventories of Functions	3	K2(U)	Lecture with illustratiuon	Suggest formulae, Solve problems, Home work
		Polya's Fundamental Theorem	3	K4(An)	Lecture using Chalk and talk, Problem solving	Slip test, Assignments

Course Focussing on Employability/ Entrepreneurship/ Skill Development : Skill Development

Activities (Em/ En/SD):**Seminar Presentation, Group Discussion, Quiz**

Assignment : The Tower of Hanoi Problem, Solution by the technique of generating functions

Seminar Topic: Linear recurrence relations with constant coefficients, Permutations with Restrictions on Relative Positions

Sample Questions:

Part-A

1. Out of a large number of pennies, nickels, dimes and quarters, in how many ways can six coins be selected?

   a) 6 b) 84 c) 60 d) 3

2. What is the coefficient of the term x^{23}in $(1 + x^5 + x^9)^{100}$?

   a) 485500 b) 485000 c) 485100 d) 481000

3. Write the recurrence relation representing the series $1, 3, 3^2, 3^3, \ldots, 3^n$

4. Draw a chessboard that has Rook polynomial 1+2x+x2

5. What is the number of distinct strings of length 3 made up of blue beads and yellow beads?

Part – B

6. If no three diagonals of a convex decagon meet at the same point inside the decagon into how many line segments are the diagonals divided by their intersections.

7. Prove the identity $\binom{n}{0}^2 + \binom{n}{1}^2 + \binom{n}{2}^2 + \cdots \binom{n}{n}^2 = \binom{2n}{n}$

8. Solve the recurrence relation using generating function $a_n = a_{n-1} + 2(n-1)$with the boundary condition $a_1 = 2$.

9. Let n books be distributed to n children. The books are returned and distributed to the children again later on. In how many ways can the books be distributed so that no children will get the same book twice.

10. Find the number of distinct bracelets of five beads made up of yellow, blue and white beads.

Part – C

11. (i) Find the number of n-digit binary sequences that contain an even number of 0's.?

(ii) What is the number of n digit quaternary sequence that has even number of zero's?

12. (i) Find the number of ways in which 4 persons, each rolling a single die once, can have total score of 17?

(ii) What is the ordinary enumerator for the selection of r objects out of n objects $(r \geq n)$,with unlimited repetitions, but with each object included in each selection.

13. State and prove the principle of inclusion and exclusion.

14. Find the number of integers between 1 and 250 that are not divisible by any of the integers 2, 3, 5 and 7

15. State and prove Polya's theorem.

Head of the Department | **Course Instructor**

Dr. T. Sheeba Helen | **Dr.J. Befija Minnie**