DEPARTMENT OF MATHEMATICS (S.F)

Vision

To empower women globally competent with human values and ethics acquiring academic and entrepreneurship skills through holistic education.

Mission

- To create opportunities which will ensure academic excellence in critical thinking, humanistic and scientific inquiry.
- To develop application-oriented courses with the necessary input of values.
- To create a possible environment for innovation, team spirit and entrepreneurial leadership.
- To form young women of competence, commitment and compassion

PG

PG PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

POs	Upon completion of M. Sc. Degree Programme, the graduates will be able to:	Mapping with Mission
PEO1	apply scientific and computational technology to solve social and ecological issues and pursue research.	M1, M2
PEO2	continue to learn and advance their career in industry both in private and public sectors.	M4 & M5
PEO2	develop leadership, teamwork, and professional abilities to become a more cultured and civilized person and to tackle the challenges in serving the country.	M2, M5 & M6

PG PROGRAMME OUTCOMES (POs)

POs	Upon completion of M.Sc. Degree Programme, the graduates will be able to:	Mapping with PEOs
PO1	apply their knowledge, analyze complex problems, think independently, formulate and perform quality research.	PEO1 & PEO2
PO2	carry out internship programmes and research projects to develop scientific and innovative ideas through effective communication.	PEO1, PEO2 & PEO3
PO3	develop a multidisciplinary perspective and contribute to the knowledge capital of the globe.	PEO2
PO4	develop innovative initiatives to sustain ecofriendly environment	PEO1, PEO2
PO5	through active career, team work and using managerial skills guide people to the right destination in a smooth and efficient way.	PEO2
PO6	employ appropriate analysis tools and ICT in a range of learning scenarios, demonstrating the capacity to find, assess, and apply relevant information sources.	PEO1, PEO2 & PEO3
PO7	learn independently for lifelong executing professional, social and ethical responsibilities leading to sustainable development.	PEO3

Programme Specific Outcomes (PSOs)

PSO	Upon completion of M.Sc. Degree Programme, the graduates of Mathematics will be able to :	PO Addressed
PSO – 1	Acquire good knowledge and understanding, to solve specific theoretical & applied problems in different area of mathematics & statistics	PO1 & PO2

PSO – 2	Understand, formulate, develop mathematical arguments, logically and use quantitative models to address issues arising in social sciences, business and other context /fields.	**PO3 & PO5**
PSO – 3	Prepare the students who will demonstrate respectful engagement with other's ideas, behaviors, beliefs and apply diverse frames of references to decisions and actions	**PO6**
PSO – 4	Pursue scientific research and develop new findings with global impact using latest technologies.	**PO4 & PO7**
PSO – 5	Possess leadership, teamwork and professional skills, enabling them to become cultured and civilized individuals capable of effectively overcoming challenges in both private and public sectors	**PO5& PO7**

I PG

Teaching Plan

Advanced Algebra

Department : Mathematics (SF)
Class : I M.Sc. Mathematics (SF)
Title of the Course : Core IV: Advanced Algebra
Semester : II
Course Code : MP232CC1

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

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

CO	Upon completion of this course, the students will be able to:	Cognitive level
CO -1	exhibit a foundational understanding of essential concepts, including field extensions, roots of polynomials, Galois Theory, and finite extensions	K1 (R)
CO - 2	Demonstrate knowledge and understanding of the fundamental concepts including extension fields, Galois Theory, automorphisms and finite fields	K2 (U)
CO - 3	compose clear and accurate proofs using the concepts of field extension, Galois Theory and finite field	K3 (Ap)
CO - 4	examine the relationships between different types of field extensions and their implications by applying algebraic reasoning	K4 (An)

CO - 5	evaluate the validity of statements and theorems in field theory by providing proofs or counter examples	K5 (E)
CO - 6	develop novel results or theorems in field theory, potentially by exploring extensions of existing theories	K6 (C)

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

Unit	Module	Topics	Teaching Hours	Cognitive level	Pedagogy	Assessment/ Evaluation
I						
	1	Extension Fields, dimension, subfield-Introduction and definition, Theorems based on extension fields	4	K2 (U)	Introductory session, Lecture with illustration	Questioning, Recall steps, concept with examples
	2	Definition and Theorems on algebraic over a field F, Theorems on algebraic extension	4	K4 (An)	Flipped classroom	Group discussion
	3	Interpretation of Extension fields such as finite extension, algebraic extension	5	K3 (Ap)	Lecture with illustration, Peer tutoring	Slip Test
	4	Transcendence of e, Problems	5	K5 (E)	Problem solving	Brainstorming

II						
	1	Definition- roots of polynomials, multiplicity of roots, Remainder theorem	3	K1 (R)	Lecture using videos	Evaluation through short test
	2	Theorems based on roots of polynomials, Existence theorem of splitting fields	4	K2 (U)	Flipped classroom	concept definitions, concept with examples
	3	Theorems based on isomorphism of fields, Theorems based on splitting field of polynomials	4	K2 (U)	Blended learning	Quiz using Nearpod
	4	Uniqueness theorem of splitting fields	3	K3 (An)	Context based	Slip Test, Quiz using gooogle forms
	5	Definition- derivative of polynomials, Simple extension, Theorems on simple extension	4	K3 (Ap)	Reflective Thinking	Formative Assessment I, Brainstorming
III						
	1	Definition -Fixed Field, Group of automorphism,	4	K2 (U)	Demonstrative	concept with examples, Questioning
	2	Theorems on Fixed Field, Theorems on Fixed Field	4	K2 (U)	Lecture Method	Evaluation through short test
	3	Theorems on Group of Automorphism, Theorems on Normal Extension	5	K3 (Ap)	PPT	Group discussion
	4	Theorems on Galois Group, Construct theorems on Normal Extension and Galois Group, Problems	5	K5 (E)	Problem solving	concept explanations

IV						
	1	Definition -Finite Fields, Characteristic of F with examples	4	K4 (An)	Introductory session	concept with examples, Assignment
	2	Theorems based on Finite Fields and Characteristic of F	5	K2 (U)	Context based	concept explanations, Quiz using Slido
	3	Finite field and Cyclic group	5	K4 (An)	Brainstorming	concept explanations, Evaluation through short test
	4	Wedderburn's Theorem on finite division ring	4	K3 (Ap)	Lecture Method	Group discussion
V						
	1	Solvability by radicals – Introduction, Solvable and Commutator group	3	K2 (U)	Lecture Method	concept with examples, Seminar
	2	Lemma and Theorem based on solvable by radicals, General polynomial definition and theorem	3	K2 (U)	Demonstrative	Slip Test, Seminar
	3	Definitions - algebraic over F and Frobenius theorem	4	K3 (Ap)	Demonstrative	Oral Test, Seminar

	4	Internal quaternions and Lagrange identity	4	K4 (An)	Computational thinking	Evaluation through short test, Seminar
	5	Left-Division algorithm, Four-Square Theorem	4	K2 (U)	Lecture Method	Quiz using Mentimeter, Formative Assessment II

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

Activities (Em/ En/SD): Solve practical problems in networking and communication

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

Activities related to Cross Cutting Issues: Nil

Assignment: Finite Fields

Seminar Topic: Frobenius theorem

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: $\Phi_3(\mathrm{x}) = x^2 + x + 1$ 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)) ≤ [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: Dr.S.Kavitha **Course Instructor: Dr.C.Jenila**

Real Analysis II

Department : **Mathematics**

Class : **I M.Sc. Mathematics**

Title of the Course : **Core Course V: Real Analysis II**

Semester : **I**

Course Code : **MP232CC2**

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP231CC2	5	1	-	-	4	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

CO	Upon completion of this course, the students will be able to:	PSO addressed	Cognitive level
CO - 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.	PSO - 1	K1 &K2
CO - 2	compare Boral measure with Lebesgue measure and the total derivatives with partial derivatives.	PSO - 2	K3

CO - 3	Determine the matrix representation and Jacobian determinant of functions.	PSO - 1	K3
CO - 4	Analyze the properties of measurable functions, Riemann and Lebesgue Integrals, convergence of Fourier series and extrema of real valued functions.	PSO - 2	K4
CO-5	test measurable sets and measurable functions.	PSO - 2	K5

Total contact hours: 75 (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 - Measurable sets - Regularity	4	K1, K2	Lecture with illustration	Q & A
	2.	Measurable Functions – Definitions - Borel function, almost everywhere, essential supremum, essential infimum, essentially bounded	5	K2, K5	PPT using Gamma AI	Short test
	3.	Borel and Lebesgue Measurability	4	K3	Lecture with illustration	Slip test
II	**Integration of Functions of a Real Variable**					
	1.	Riemann Integrals	1	K2	Brainstor ming	Q &A
	2.	Integration of Non- negative functions – Lebesgue Integral	5	K2, K3	Blended classroom	Slip test
	3.	The General Integral - Riemann and Lebesgue Integrals – Riemann Integrable function	5	K4	Discussion and Lecture	Quiz using nearpod
III	**Fourier Series and Fourier Integrals**					
	1.	Introduction - Orthogonal system of functions - The theorem on best approximation	4	K2	Brainstorming Lecture with illustratio n	Quiz using Slido

	2.	The Fourier series of a function relative to an orthonormal system - Properties of Fourier Coefficients - The Riesz-Fischer theorem	4	K2, K4	Lecture	Solving Exercise Poblems
	3.	The convergence and representation problems for trigonometric series - The Riemann-Lebesgue lemma - The Dirichlet integrals - An integral representation for the partial sums of Fourier series	5	K2, K4	Seminar Presentation	Short test Assignment – Exercise roblems
	4.	Riemann's localization theorem - Sufficient conditions for convergence of a Fourier series at a particular point –	4	K4	Seminar Presentation	Questioning
	5.	Cesaro summability of Fourier series- Consequences of Fejes's theorem - The Weierstrass approximation theorem.	4	K4	Seminar Presentation	Slip Test
IV	**Multivariable Differential Calculus**					
	1.	Introduction - The directional derivative - Directional derivative and continuity -	3	K1 & K2	PPT	Quiz using Slido

	2.	The total derivative - The total derivative expressed in terms of partial derivatives	3	K3	Lecture with illustration	Problem Solving
	3.	The matrix of linear function - The Jacobian matrix - The chain rule - Matrix form of chain rule	3	K3	Seminar Presentation	Questioning
	4.	The mean-value theorem for differentiable functions - A sufficient condition for differentiability	3	K2	Seminar Presentation	Short test
	5.	A sufficient condition for equality of mixed partial derivatives - Taylor's theorem for functions of R^n to R^1	3	K3, K4	Lecture with chalk and talk	Slip Test
V	**Implicit Functions and Extremum Problems**					
	1.	Introduction - Functions with non-zero Jacobian determinants – The inverse function theorem	4	K3	PPT using Gamma AI	Q & A
	2.	The implicit function theorem	3	K2, K4	Lecture with illustration	Concept explanations
	3.	Extrema of real valued functions of one variable	3	K2, K4	Interactive PPT	Questioning
	4.	Extrema of real-valued functions of severable variables-Extremum problems with side conditions.	5	K4	Lecture	Slip test

Course Focussing on Employability/ Entrepreneurship/ Skill Development: Skill

DevelopmentActivities (Em/ En/SD): Problem-solving, Seminar Presentation,

Quiz Competition

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

Activities related

to Cross Cutting

Issues: -Nil

Assignment:

Solving Exercise

Problems

Seminar Topic: Fourier Series and Fourier Integrals, Multivariable Differential Calculus

Sample Questions:

Part A

1. Say true or false: Outer measure is translation invariant.

2. $\int_1^{\infty} \frac{dx}{x} =$ _____

3. The length of the vector $\bar{x} = (x_1, x_2, \dots, x_n)$ in $R^n$is _____

4. If $u = u_k$, the kth unit coordinate vector, then $\boldsymbol{f'(c, u_k)}$ is

called a _____.

5. If a function **f** has continuous partial derivatives on a set S,

we say that **f** is _____ on S.

Part B

1. Prove that every non measurable set is a Borel set.
2. If f is Riemann integrable and bounded over the finite interval [a,b],then prove that f is integrable and **R**$\int_a^b f\,dx = \int_a^b f\,dx$.
3. State and prove Bessel's inequality.
4. Assume **f** is differentiable at **c** with total derivative $\boldsymbol{T_c}$**.** Then prove that the directional derivative $\boldsymbol{f'(c;u)}$ exists for every **u** in R^n and we have $\boldsymbol{T_c(u)} = f'(c;u)$.
5. Let A be an open subset of R^n and assume that $f: A \to R^n$ has continuous partial derivatives $D_i f_i$ on A. If $J_f(\boldsymbol{x}) \neq 0$ for all **x** in A, then prove that **f** is an open mapping.

Part C

1. Prove that outer measure of an interval equals its length.
2. State and prove Lebesgue's Dominated Convergence Theorem.
3. Let $\{\varphi_0, \varphi_1, \varphi_2, \ldots..\}$ be orthonormal on I, and assume that $f \in L^2(I)$. Define two sequences of functions $\{s_n\}$ and $\{t_n\}$ on I as follows :$s_n(x) = \sum_{k=0}^{n} c_k\varphi_k(x)$, $t_n(x) = \sum_{k=0}^{n} b_k\varphi_k(x)$ where $c_k = (f, \varphi_k)$ for $k = 0,1,2,\ldots.$ and $b_0, b_1, b_2, \ldots..$ are arbitrary complex numbers. Then prove that for each n, we have $\|f - s_n\| \leq \|f - t_n\|$.
4. Assume that one of the partial derivatives $D_1\boldsymbol{f}, \ldots., D_n f$ exists at c and that the remaining n-1 partial derivatives exist in some n-ball B(c) and are continuous at c. Then prove that **f** is differentiable at **c**.
5. State and prove Inverse function theorem.

Head of the Department

Course Instructor

J. Anne Mary Leema

Dr. S.Kavitha **Mrs.J.Anne Mary Leema**

Partial Differential Equations

Semester **: II**

Name of the Course **: Partial Differential Equations**

Course code **: PM2023**

Major Core **: VII**

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PM2023	5	1	-	-	4	6	90	25	75	100

Objectives:

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

Course Outcomes

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

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

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

Unit	Module	Topics	Teaching Hours	Cognitive level	Pedagogy	Assessment/ Evaluation
I	**Non-linear Partial Differential Equations of First Order**					
	1	Explanation of terms,compactible system of first order equations,Examples related to compactible system	3	K1(R)	Lecture using chalk and talk	Evaluation through Quiz
	2	Charpit's Method and problems, Problems related to charpit's method	4	K2(U)	Lecture using videos	Evaluation through short test
	3	Problems related to charpit's method	2	K2(U)	Problem solving	Evaluation through MCQ
	4	Solving problems using charpit's method	3	K3(Ap)	Peer teaching, Group Discussion	Evaluation through short slip test
	5	Problems related to charpit's method	3	K3(Ap)	Problem solving	Evaluation through Assignment
II	**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,TheoremI,II	2	K2(U)	Lecture using chalk and talk	Evaluation through Test
	2	Method of finding complementary function, Working rule for finding complementary function ,Alternative working rule for finding complementary function	2	K2(U)	Lecture using PPT	Evaluation through Assignment
	3	Some examples for finding Complementary function	3	K2(U)	Problem solving	Evaluation through slip Test
	4	General method and working rule for finding the particul integral of homogeneous equation and some example	3	K2(U)	Lecture using chalk and talk	Evaluation through Test
	5	Examples to find the particular integral	3	K3(Ap)	Problem solving	Evaluation through quiz
III	**Non–homogeneous Linear Partial Differential Equations with Constant Coefficient**					
	1	Definition, Reducible and irreducible linear differential operators, Reducible and irreducible linear partial differential equations with constant coefficient, Determination of complementary function	2	K2(U)	Lecture using PPT	Evaluation through Assignment
	2	General solution and particular integral of non-homogeneous equation and some examples of type1	3	K2(U)	Lecture using chalk and talk	Evaluation through Assignment

	3	Some examples of type2	3	K3(Ap)	Problem solving	Evaluation through Assignment
	4	Some problems related to type3	3	K3(Ap)	Peer teaching, Group Discussion	Evaluation through Formative Assessment
	5	Examples related to type4, Miscellaneous examples for the determination of particular integral	4	K4(An)	Problem solving	Evaluation through Assignment
IV	**Classification of P.D.E. Reduction to Canonical(or normal) Forms**					
	1	Classification of Partial Differential equations of second order – Classification of P.D.E. in three independent variables	2	K2(U)	Lecture using chalk and talk	Evaluation through quiz
	2	Cauchy's problem for a second order P.D.E. Characteristic equation and Characteristic curves of the second order P.D.E.	2	K2(U)	Lecture using PPT	Evaluation through slipTest
	3	Laplace Transformation .Reduction to Canonical(or normal) forms.(Hyperbolic type)	4	K3(Ap)	Lecture using videos	Evaluation through Assignment
	4	Laplace Transformation ,Reduction to Canonical (or normal) forms.(Parabolic type)	4	K4(An)	Problem solving	Evaluation through MCQ
	5	Laplace Transformation .Reduction to Canonical(or normal) forms.(Elliptic type)	3	K4(An)	Peer teaching, Group Discussion	Evaluation through short Test
V	**Boundary Value Problem**					

	1	A Boundary value problem, Solution by Separation of variables, Solution of one dimensional wave equation, D'Alembert's solution, Solution of two dimensional wave equation	3	K2(U)	Lecture using chalk and talk	Evaluation through Quiz
	2	Vibration of a circularmembrane, Examples related to vibration of a circularmembrane	4	K3(Ap)	Lecture using PPT	Evaluation through slipTest
	3	Solution of one dimensional heat equation, Problems related to solution of one dimensional heat equation	4	K2(U)	Lecture using videos	Evaluation through Formative Assessment
	4	Solution of two dimensional Laplace's equation	3	K4(An)	Peer teaching, Group Discussion	Evaluation through quiz
	5	Solution of two dimensional heat equation	3	K3(Ap)	Problem solving	Evaluation through Assignment

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

Activities (Em/ En/SD): Solving the Problems, Group discussion, Seminar, Online Assignment

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

Activities related to Cross Cutting Issues: Nil

Assignment : Cauchy's problem for a second order P.D.E.
Characteristic equation and Characteristic curves of the second order P.D.E, Solution of two dimensional heat equation.

Seminar Topic: Laplace
Transformation ,Reduction to Canonical (or normal) forms.(Parabolic type)

Sample Questions

PART –A

1.State the condition of First order PDEs are Compatible.

2. Solve $\left(\frac{\partial^2 z}{\partial x^2}\right)-\left(\frac{\partial^2 z}{\partial y^2}\right)=0$

3. Solve the partial differential equation t + s +q =0

4. Write the steps to reducing a hyperbolic equation to its canonical form.

5.Find the D'Alambert's solution for wave equation

PART- B

1. Find a complete integral of px+ qy = pq

2. Solve $(D^2+DD'-6D'^2)z = y \sin x$

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

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

5. Obtain the steady state temperature distribution in a rectangular metal plate of length a and width b ,the sides of which are kept at temperature 0^0C the lower edge is kept at 100^0 C and the upper edge kept insulated.

PART-C

1. Show that the equations f(x,y,p,q) =0 , g((x,y,p,q) =0 are compatible if $\frac{\partial(f,g)}{\partial(x,p)}+\frac{\partial(f,g)}{\partial(y,q)}=0$ .Verify that the equations p = P(x,y),q = Q(x,y) are Compatible if $\frac{\partial P}{\partial y}=\frac{\partial Q}{\partial x}$

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

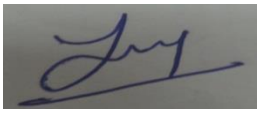
3. Solve $(D^2-DD'-2D)z = \sin (3x +4y) +x^2 y$

4. 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.

5.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 are kept at zero temperature .Determine the temperature at a point of the plate as t increases.

Head of the Department
Dr. S.Kavitha



Course Instructor
Dr. J. Nesa Golden Flower

Statistical Data Analysis Using R Programming

Class : I M. Sc Mathematics
Title of the Course :Elective III: Statistical Data Analysis Using R Programming
Semester : II
Course Code : MP232EC2

Course Code	L	T	P	Credits	Inst. Hours	Total Hours	Marks		
							CIA	External	Total
MP232EC2	4	-	-	4	4	60	25	75	100

Objectives

1. The basics of statistical computing and data analysis.
2. How to use R for analytical programming.

Course outcomes

CO	Upon completion of this course, the students will be able to:	PSO addressed	Cognitive level
CO – 1	recall R and its development history	PSO – 1	**K1**
CO – 2	demonstrate how to import and export data with R	PSO – 2	**K2 & K4**
CO – 3	explain discrete distributions	PSO – 4	**K3**
CO – 4	apply various concepts to write programs in R	PSO – 3	**K3 & K5**
CO – 5	apply estimation concepts in R programming	PSO – 5	**K2 & K3**

Teaching plan

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

Unit	Module	Topic	Teaching Hours	Cognitive level	Pedagogy	Assessment/ Evaluation
I						
	1.	Introduction about Data	1	K1(U)	Introductory session	Simple definitions
	2.	Introduction about Data Analysis	2	K2(R)	Problem solving	Diagnostic test
	3.	Statistical Software R	2	K2(U)	Lecture using Chalk and talk	Word Cloud
	4.	Development history of R	3	K2(U)	Interactive PPT	Quiz using slido
	5.	Structure of R	3	K2(U)	Computational Thinking	Evaluation essay
	6.	Installation of R	1	K3(A)	Demonstration	Installation of R Studio
II						
	1.	Descriptive Statistics	2	K1(R)	Lecture using Chalk and talk	Evaluation through short test
	2.	Basics of R	2	K2(U)	Lecture	Map knowledge
	3.	Excursus: Data Import and Export with R	3	K2(U)	Demonstration	Practical Exercises
	4.	Import of ICU	3	K3(A)	Gamification	Puzzle

	5.	Dataset	2	K3(A)	Inquiry Based Teaching	Prepare a sheet
III						
	1.	Colors and Diagrams- An Introduction	2	K2(U)	PPT	Short essays
	2.	Colors- Recommendations for handling colors	2	K1(R)	Project Based	MCQ Using Slido
	3.	Overview of devices supported by R	2	K5(U)	Flipped Classroom	MCQ Using Nearpod
	4.	Excursus: Export of diagrams	3	K4(An)	Demonstration	Slip test
	5.	Diagrams	3	K3(A)	Blended Learning	MCQ Using Nearpod
IV						
	1.	Probability Distributions	2	K2(U)	Context Based	Short summary
	2.	Bernoulli Distribution, Binomial Distribution	1	K3(A)	Lecture using videos	Exercises to solve
	3.	Discrete Distributions	2	K3(A)	Computational Learning	Short Summary
	4.	Cumulative Distribution	2	K4(An)	PPT	Evaluation through short test
	5.	Hypergeometric Distribution	2	K3(A)	Demonstration	Short summary

	6.	Continuous Distributions	2	K6(A)	Experimental Learning	Evaluation through short test
	7.	Normal, Log-Normal Distributions	1	K5(E)	Demonstration	Solving Puzzles
V						
	1.	Estimation – An Introduction	2	K1(R)	Demonstration	True/False
	2.	Simple Parametric models	2	K3(A)	Lecture	Evaluation through problems
	3.	Estimator Construction	3	K3(A)	Problem solving	Recall Steps
	4.	Confidence Intervals	3	K4(An)	Lecture method	MCQ
	5.	Point Estimation	2	K3(A)	Problem solving	Short essays

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

1. Activities (Em/ En/SD): 1. Load a dataset (e.g., iris or mtcars) using R.
2. Use functions like summary(), mean(), median(), sd(), var(), etc., to compute descriptive statistics.
3. Interpret the summary statistics obtained and visualize the data using histograms, boxplots, or scatter plots.

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

Activities related to Cross Cutting Issues : Nil

Assignment :

1. Continuous Distributions
2. Point Estimation

Seminar Topic:

1. Diagrams
2. Binomial Distribution

Sample questions (minimum one question from each unit)

Part A

1. What statistical measures are commonly used to describe central tendency?

A. Mean, Mode, Range

B. Mean, Median, Mode

C. Median, Variance, Standard Deviation

D. Median, Mode, Range

2. Which type of probability distribution deals with continuous variables?

A. Binomial Distribution B. Poisson Distribution

C. Normal Distribution D. Exponential Distribution

3. What does "point estimation" in statistics refer to?

A. Estimating a range of values for a population parameter

B. Estimating the standard deviation of a sample

C. Estimating a single value for a population parameter

D. Estimating the probability of an event

4. In R, which function is commonly used for importing external datasets?

A. importData() B. read.csv() C. loadData() D. importDataset()

5. Which probability distribution deals with continuous variables and is commonly associated with the bell curve?

A. Poisson Distribution B. Binomial Distribution

C. Normal Distribution D. Exponential Distribution

Part B

1. Describe the step-by-step process of installing R on different operating systems.

2. Discuss the importance of measures of central tendency in statistical analysis. Compare and contrast the use of mean, median, and mode in various real-world scenarios.

3. Explain the process of importing the ICU-Dataset into R. Discuss the various functions or methods available in R for importing different types of data.

4. Elaborate on the role of colors in data visualization using R.

5. Detail the process of exporting diagrams or plots created in R.

Part C

1. Explain the architecture and internal components of R.

2. Explore the role of data import and export functionalities in R.

3. Analyze the significance of colors in data visualization and interpretation.

4. Investigate the concept of probability distributions in statistics. Compare and contrast discrete and continuous probability distributions, elucidating their properties and applications in real-world scenarios.

5. Discuss the implications of exporting visual representations in various formats and resolutions for sharing and publishing research findings.

Dr.S.Kavitha

Head of the Department

Dr.S.Immaculate Shyla

Course Instructor

Mathematical Python

Semester **: IV**

Name of the Course **: Mathematical Python**

Course code : MP232DE2

CourseCode	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP232DE2	3	-	1	-	3	4	60	25	75	100

Objectives:

1. To familiarize the students with Python programing for Mathematics
2. To train them to develop programs and create Functions for Mathematics in Python.

Course Outcomes

CO	Upon completion of this course the students will be able to	PSO Addressed	CL
CO - 1	acquire knowledge on Python and learn to run the program.	PSO - 2	K1(R)
CO - 2	understand and discuss about different data types and flow control statements .	PSO - 1	K2(U)
CO - 3	write programs in python using Lists Tuples, Sets and Dictionaries	PSO - 3	K5(E)
CO - 4	understand For and While loops and conditional statements.	PSO - 1	K2(U)

CO - 5	creates Functions and Arrays in Python	PSO - 5	K6(C)

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

Unit	Module	Topics	Lecture hours	Cognitive Level	Learning Outcomes	Pedagogy	Assessment/ evaluation
I	**Running Python**						
	1	Python Getting started	2	K1 (R) K2 (U)	To understand the basic python getting started	Lecture with illustration and PPT	Observation note concept definitions, concept explanations
	2	Installing Python	3	K5 (E)	To get method of installing python	Lecture using videos	Formative Assessment
	3	Different tabs in Jupyter notebook	4	K3 (A)	To discuss different tabs in jupyter	Peer tutoring, problem solving	Evaluation through short test, solve problems Test
	4	Magics, Markdown	2	K5 (E)	To understand the Magics instruction and Markdown	Lecture with Group Discussion	concept definitions, concept with examples Quiz
II	**Programming Python**						
	1	Python data types	7	K2 (U)	To get the idea of formation of python data types	Blended Teaching	Quiz questioning in the classroom
	2	Containers	5	K2 (U)	To understand arranging the sets in container	Problem solving	concept explanations

							,Quiz, solve problems
	3	Controlling the flow	3	K3 (A)	To determine the controlling the flow	Lecture with PPT	concept definitions, concept with examples Slip Test
III	**Packaging and reusing the code**						
	1	Functions	3	K2 (U)	To evaluate function code	Lecture with illustration	Formative Assessment
	2	Modules, Comprehensions	4	K4 (Ap)	To understand modules and comprehensions	Lecture method, Group Discussion, Lecture using videos	MCQ concept definitions, concept with examples
	3	General expression and Comments	3	K3 (A)	To explain general expressions and comments	Lecture with Group Discussion	Formative Assessment Open Book Test
IV	**Numerical Computing**						
	1	Numpy Array creation, Array properties	3	K2 (U)	To create numpy array and array properties	Lecture using PPT and Peer teaching	concept with examples Creative writing
	2	Array operation	3	K4 (Ap)	To determine array operation	Lecture using videos and Problem solving	Formative Assessment
	3	Array indexing and slicing	3	K3 (A)	To determine the indexing and slicing	Lecture with Group Discussion	concept with examples Assignment

	4	Indexing with integer Arrays and Boolean Arrays	3	K2(U)	To find the indexing with integer arrays	Lecture with Group Discussion	Slip Test
V	**Differential Equations**						
	1	First order differential equations	3	K2 (U)	To find the first order differential equations	Lecture with Gamma PPT	concept with examples Quiz Surprise Test
	2	Higher Order differential equations	3	K4 (Ap)	To understand the Higher order differential equations	Lecture with Illustration, Group Discussion and Peer teaching	Evaluation through short test, MCQ, True/False, Questioning and Home Assignment Oral Test
	3	Systems of equations	6	K3 (A)	To evaluate the system of equation	Group Discussion, Lecture using PPT and Peer teaching	Recall steps, Assignment, Questioning and Home Assignment Formative Assessment

Course Focussing on Employability/ Entrepreneurship/ Skill Development: Employability

Activities (Em/ En/SD): Solving the Problems, Group discussion, Seminar, Online Assignment

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

Activities related to Cross Cutting Issues: Nil

Assignment: Array indexing and slicing

Seminar Topic: Indexing with integer Arrays and Boolean Arrays

Part-A (5x1 = 5marks)

1. What is the purpose of the pip tool in Python?

a) To create virtual environments b) To install Python packages.
c) To write documentation in Python d) To execute Python scripts

2. In a Jupyter Notebook, which tab is used for managing the running kernels and their outputs?
   a) Home b) Insert c) Kernel d) Cell

3. What does the %matplotlib inline magic command do in a Jupyter Notebook?
   a) Imports the matplotlib library b) Displays matplotlib plots directly in the notebook
   c) Measures the execution time of code cells d) Enables inline comments in the notebook

4. In Jupyter Notebook, which type of cell is used for rendering text and Markdown?
   a) Code b) Raw NBConvert c) Markdown d) Header

5. What is the purpose of the "Code" cell type in Jupyter Notebook?
   a)It contains only code that will be executed b) It is used for writing text and comments
   c) It represents a raw, unformatted text d) It includes HTML and JavaScript code

Part-B(5x6 = 30marks)

1. Explain the concept of Python data types and their significance in programming.
2. Discuss the role of containers in Python programming, focusing on lists, tuples, and dictionaries. Provide examples to demonstrate how each container type is used, and compare their strengths and weaknesses.
3. How does Python's indentation-based syntax contribute to code readability?
4. Explain the advantages of using NumPy arrays in numerical computing tasks.
5. Discuss the role of modules in code modularity and reuse.

Part-C(5x12 = 60marks)

1. Explore the functionalities of Jupyter Notebook, highlighting the different tabs and their purposes.
2. Provide examples to illustrate the use of functions, modules, and comprehensions in practical scenarios.
3. Explore the key aspects of Numerical Python (NumPy) related to array creation, properties, operations, and indexing.
4. Discuss the representation and solution of first-order and higher-order differential equations in Python.
5. Explore the importance of code packaging and documentation in Python.

Course Instructor

Dr. P.C. Priyanka Nair

Head of the Department

Dr. S. Kavitha

Modeling and Simulation with Excel

Department : **Mathematics**

Class : **I M.Sc. Mathematics**

Title of the Course : **Skill Enhancement I: Modeling and Simulation with Excel**

Semester : **II**

Course Code : **MP232SE1**

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

Learning Objectives

1. To know about modifying a spreadsheet and workbook.

2. To understand the concept of data analysis tools and data analysis for two data sets.

Course Outcomes

On the successful completion of the course, students will be able to:

CO-1	Learn the spreadsheet and workbook.	K1 & K2
CO-2	Understand the types of charts and graphs.	K2 & K4
CO-3	Apply the custom data formats and layouts.	K3 & K4
CO-4	Analyze the data with Excel.	K4 & K5
CO-5	Create spreadsheets, workbooks and charts.	K2 &K6

Total contact hours: 45 (Including instruction hours, 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	K1, K2	Lecture with illustration	Q & A
	2.	Julia's Business Problem-A Very Uncertain Outcome	3	K1, K2	Lecture with illustration	Short test
	3.	Ram's Critique, Julia's New and Improved Workbook.	3	K1, K2	PPT using Gamma AI	Slip test
II	**Presentation of Quantitative Data: Data Visualization**					
	1.	Introduction - Data Classification	2	K4,K5	Lecture using PPT	Q &A
	2.	Data Context and Data Orientation	3	K4,K5	Blended classroom	Slip test

	3.	Data Preparation Advice	4	K4, K5	Lecture and Discussion	Quiz using nearpod
III	**Types of Charts and Graphs**					
	1.	Ribbons and the Excel Menu System, Some Frequently Used Charts	3	K2, K4	Lecture with illustration	Quiz using Slido
	2.	Specific Steps for Creating a Chart	2	K2, K4	Lecture with PPT	Slip test
	3.	An Example of Graphical Data Analysis and Presentation, Example – Tere's Budget for the 2nd Semester of college, Collecting Data, Summarizing Data, Analyzing Data, Presenting Data.	4	K4, K5	Lecture with illustration	Exercise problems
IV	**Analysis of Quantitative Data**					
	1.	Introduction, Data Analysis, Data Analysis Tools	1	K4 & K5	PPT	Quiz using Slido
	2.	Data Analysis for Two Data Sets – Time Series Data: Visual Analysis, Cross-Sectional Data: Visual Analysis	4	K4 & K5	Lecture with illustration	Short test
	3.	Analysis of Time Series Data: Descriptive Statistics	2	K4 & K5	Blended classroom	Questioning
	4.	Analysis of Cross-Sectional Data: Descriptive Statistics.	2	K4 & K5	Lecture with illustration	Short test

V	**Presentation of Qualitative Data – Data Visualization**					
	1.	Introduction, Essentials of Effective Qualitative Data Presentation	1	K3,K5	PPT using Gamma AI	Q & A
	2.	Planning for Data Presentation and Preparation, Data Entry and Manipulation	3	K3,K5	Seminar presentation	Short test
	3.	Tools for Data Entry and Accuracy, Data Transposition to Fit Excel	3	K3,K5	Interactive PPT	Questioning
	4.	Data Conversion with the Logical IF, Data Conversion of Text from Non-Excel Sources	2	K3,K5	Seminar presentation	Slip test

Course Focussing on Employability/ Entrepreneurship/ Skill Development:

Employability

Activities (Em/ En/SD): Problem-solving, Seminar Presentation, Quiz

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

Activities related

to Cross Cutting

Issues: -Nil

Assignment:

Solving Exercise

Problems

Seminar Topic: Presentation of Qualitative Data – Data Visualization, Tools for Data Entry and Accuracy, Data Transposition to Fit Excel

Sample Questions:

Part A

1. Say true or false: Uncertainty in sales volume and sales price also affects the variable expenses.

2. A set of conditions or an environment related to the data is

called as _____

3. Negative correlation implies that one data series moves in the _____direction from another.
4. In a null hypothesis, the means of the underlying populations are the same, and therefore their difference is equal to ____
5. The distribution of the data elements to cells is achieved by locating the _____Command in the Data ribbon and Data Tools group**.**

Part B

1. Write short note on risk profile.
2. Write short note on data classification.
3. Write brief note on some frequently used charts.

4. What is the difference between time series and cross-sectional data?
5. Identity the following data as either qualitative or quantitative:

(a) Quarterly sales data in dollars for a SKU (stock keeping unit)

(b) The country of birth for a job applicant

(c) Your rank among your fellow high school graduates

(d) Your random assignment to one of 26 rental cars

Part C

1.Explain five best practices for workbook design.

2.Explain Data Preparation Advice.

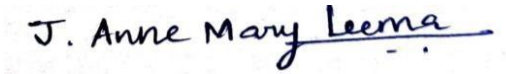
3. Elaborate on graphical data analysis and presentation.

4. Explain about performing data analysis in Excel?

5. Elaborate on (i) Data Conversion with the Logical IF (ii) Data Conversion of Text from Non–Excel Sources

Head of the Department

Dr. S.Kavitha



Course Instructor

Mrs.J.Anne Mary Leema

II PG

PROGRAMME SPECIFIC OUTCOME (PSOs)

PSO No.	Upon completion of the M.Sc. Degree Programme, the graduates will be able to:	PO addressed
PSO - 1	utilize the knowledge gained for entrepreneurial pursuits.	PO 1
PSO - 2	sharpen their analytical thinking, logical deductions and rigour in reasoning.	PO 2
PSO - 3	use the techniques, skills and modern technology necessary to communicate effectively with professional and ethical responsibilities.	PO 3
PSO - 4	Understand the applications of mathematics in a global economic environmental and societal context.	PO 4

Teaching Plan

Complex Analysis

Class : **II M.Sc Mathematics**

Title of the course : **Major Core XII -Complex Analysis**

Semester : **IV**

Name of the Course : **Complex Analysis**

Course code : **PM2041**

Course code	L	T	P	Credits	Inst. Hours	Total No. of Hours	Marks		
							CIA	External	Total
PM2021	4	2	-	6	6	90	25	75	100

Objectives:

1. To impart knowledge on complex functions
2. To facilitate the study of advanced mathematics

Course Outcomes

CO	Upon completion of this course the students will be able to	PSO Addressed	CL
CO - 1	understand the fundamental concepts of complex variable theory	PSO - 1	K1

CO - 2	effectively locate and use the information needed to prove theorems and establish mathematical results	PSO - 3	K2
CO - 3	demonstrate the ability to integrate knowledge and ideas of complex differentiation and complex integration	PSO - 4	K3
CO - 4	use appropriate techniques for solving related problems and for establishing theoretical results	PSO - 3	K2 & K3
CO - 5	evaluate complicated real integrals through residue theorem	PSO – 2, 4	K4
CO - 6	know the theory of conformal mappings which has many physical applications and analyse its concepts	PSO – 3, 4	K5

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

Unit	Module	Topics	Teaching Hours	Cognitive level	Pedagogy	Assessment/ Evaluation
I	**PowerSeries**					
	1	Abel'stheorem, Abel'slimittheorem	3	K2(U)	Introductory to Abel'stheorem	Recall basic definitions
	2	Theperiodicity	2	K3(Ap)	Lecturewith Illustration	Class Test
	3	Conformality:Arcsandclosed curves, AnalyticFunctionsinRegions	4	K4(An)	Gamification	Puzzle
	4	ConformalMapping	3	K4(An)	Seminar	SlipTest
	5	LengthandArea	2	K2(U)	Inquiry Based Teaching	Online Quiz

II	**Complex Integration–Fundamental Theorems**					
	1	Cauchy'sTheoremsfor aRectangle,Cauchy'sTheoreminaDisk	5	K2(U)	Derivations on Cauchy's Theorems for a Rectangle	Simple definitions related to rectangle
	2	Cauchy'sintegralformula,The Index of a Point withRespectto aClosed Curve	3	K3(Ap)	Lecturewith Illustration	Oral Test
	3	TheIntegralFormula,HigherDerivatives	3	K4(An)	Lecture	Formative Assessment Test I & II
	4	Local Properties ofAnalytic Functions – Removablesingularities andTaylor'stheorem, Zerosandpoles.	4	K4(An)	Inquiry Based Teaching	Online Quiz
III						
	1	The local mapping, Themaximum principle, TheGeneralFormofCauchy'sTheorem	5	K3(Ap)	Lecture using videos	Solving problems
	2	Chains and Cycles, SimpleConnectivity,Homology	4	K2(U)	Flipped classroom	MCQ using Nearpod
	3	TheGeneralStatementof Cauchy'sTheorem (statementonly),CalculusofResidues	3	K4(An)	Blended learning	Formative Assessment Test I
	4	The Residue Theorem,TheArgument Principle	2	K3(Ap)	Lecture with Illustration	Online Quiz
	5	EvaluationofDefiniteIntegrals.	2	K2(U)	Video	Oral Test
IV						
	1	Partial Fractions and Entire Functions, Partial Fractions, Infinite products, Canonicalproducts	3	K2(U)	Lecturewith Illustration	Oral Test

	2	Gamma functions, Jensen'sformula, Hadamard'sTheorem	4	K3(Ap)	Computational learning	Short summary
	3	RiemannThetaFunctionsandNormalFamilies,product development,Extension of $\zeta(s)$ $to$the Wholeplane	3	K4(An)	Experimental learning	Evaluation through online quiz
	4	The zeros of zetafunctions, Equicontinuity,Normalityand compactness	2	K4(An)	Problem solving	Recall steps
	5	Arzela's theorem,Familiesofanalytic functions,TheclassicalDefinitions	3	K2(U)	Seminar	Online Quiz
V						
	1	Riemann mappingtheorem,Statement and proof, BoundaryBehaviour,Useof the Reflectionprinciple	5	K2(U)	Lecture using videos	Recall basic definitions
	2	Conformal mappings of Polygons, Behaviour at an angle	3	K3(Ap)	Experimental learning	Evaluation through online Quiz
	3	Schwarz-Christoffel formula,Mappingon a rectangle	3	K4(An)	Problem solving	Recall steps
	4	Harmonic Functions,Functionswithmeanvalue property, Harnack'sPrinciple	4	K4(An)	Lecture using chalk and talk	Slip test

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

Activities(Em/En/SD): Evaluation through short test, Seminar

Assignment:

1.Gamma functions, Jensen's formula, Hadamard's Theorem
2. The zeros of zeta functions, Equicontinuity, Normality and compactness

Seminar Topic: Conformal mappings of Polygons, Behaviour at an angle

Sample questions:

Part-A

1. The circle…….. is called the circle of convergence of the power series

a) |Z|>R b)|Z|<R c)|Z|=R d)none

2.If ……, the series become unbounded & divergent

a) |Z|>R b)|Z|<R c)|Z|=R d)none

3.Winding number is defined by

a) n(σ, a) b)n(γ, a) c)n($\gamma, 1$) d)n($\gamma, 0$)

4.8. The value of $e^{i\pi}$ is

a) 0 b)-1 c)1 d) π

5.A constant function z(t) defines a …….

a)arc b) analytic function c) point curve d) closed curve

Part – B

Answer all the questions

11.Let R be the radius of convergence of the power series then show that converges absolutely for every Z with$|Z| < R$.

12. State and prove Cauchy's integral formula.

13. State and prove Rouche's theorem.

14. A necessary and sufficient condition for the absolute convergence of the product $\prod_1^\infty(1 + a_n)$ is the convergence of the series $\sum_1^\infty|a_n|$.

15. Suppose that the boundary of a simply connected region Ω contains a line segment γ as a one-sided free boundary arc. Then the function f(z) which maps Ωonto the unit disk can be extended to a function which is analytic and one to one on $\Omega \cup \gamma$. The image of γ is an arc γ' on the unit circle.

Part – C

Answer all the questions

16. State and prove Abel's theorem on radius of convergence of the power series.

17. State and prove Cauchy's theorem for a rectangle.

18. State and prove Residue theorem.

19. The infinite $\prod_1^{\infty}(1+a_n)$ 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.

20. State and prove Riemann mapping theorem

Head of the Department **Course Instructor**

Dr.S. KAVITHA Dr.Y.A.SHINY

Functional Analysis

Department : Mathematics (SF)
Class : II M.Sc. Mathematics (SF)
Title of the Course : Core XIII Functional Analysis
Semester : IV
Course Code : PM2042

Course Code	L	T	P	Credits	Inst. Hours	Total Hours	Marks		
							CIA	External	Total
MP231CC1	4	2	-	5	6	90	40	60	100

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

2. To enable the students to pursue research.

Course Outcome

CO	Upon completion of this course the students will be able to :	PSOs 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	K6(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	Topics	Teaching Hours	Cognitive level	Pedagogy	Assessment/ evaluation
I	**Banach Spaces**					
	1.	Introduction to Banach space	1	K1 (R)	Introductory session	Simple definitions, Recall basic concepts
	2.	Definition and, examples of normed linear space and Banach Space, Small preliminary results and theorem on	2	K1 (R) K2 (U)	Interactive PPT	MCQ

		Normed linear space.				
	3.	Properties of a Closed unit sphere, Holder's Inequality and Minkowski's Inequality.	3	K1 (R) K2 (U)	Lecture with illustrations	Group Discussion
	4.	Equivalent conditions theorem on continuous linear transformations, $B(N,N^1)$is a Banach space, Functionals and it's properties.	4	K2 (U) K3(Ap)	Flipped Classroom	Evaluation through slip test
	5.	Definition of an Operator and small results on operators, Side result of Hahn Banach theorem and Hahn Banach theorem, Theorem based on functional in N*, Problems based on Normed linear spaces	5	K1 (R) K3(Ap)	Computational learning	MCQ using Nearpod
II	**Conjugate space**					
	1.	Definitions of second conjugate space, induced functional, weak topology,	4	K1 (R) K3(Ap)	Lecture using videos	Evaluation through short test

		weak* topology, Strong topology,				
	2.	Theorem on isometric isomorphism of Open mapping theorem and Open mapping theorem	4	K2 (U) K6(C)	Blended learning	Home Assignment
	3.	Definition of Projection and Theorem on Projection, Closed Graph Theorem,	4	K1 (R) K3(Ap)	Lecture with illustration.	MCQ using slido
	4.	The conjugate of an operator , the Uniform , Boundedness theorem and theorem on isometric isomorphism	3	K2 (U) K3(Ap)	Computational Learning	Online Assignment
III	**Hilbert Space**					
	1.	Definition and examples of Hilbert Space, Properties of a Hilbert Space, Schwarz Inequality, Parallelogram law, Theorem on Convex subset of a Hilbert Space	3	K2 (U) K3(Ap)	Lecture with illustration	MCQ

	2.	Theorem on Orthogonal Complements and theorem on closed linear subspaces	3	K1 (R) K3(Ap)	Evaluative Learning	Formative Assessment Test I
	3.	Definition and examples of orthonormal set, Bessel's Inequality and Theorems on Orthonormal Sets	5	K2 (U) K3(Ap)	Brain storming	Oral Test
	4.	Gram –Schmidt Orthogonalization Process Theorem on Conjugate Space H*	4	K1 (R) K3(Ap)	Interactive PPT	Short summary
IV	**Adjoint operator**					
	1.	Definition and small results, Theorem on the properties of an adjoint operator	3	K1 (R) K4(An)	Lecture with illustration	Oral Test
	2.	Theorem-The set of all self adjoint operators is a real Banach space, Theorems on self adjoint operators	3	K2 (U) K4(An)	Interactive PPT Gamma AI	MCQ

	3.	Properties on Normal and Unitary Operators , Theorems on Normal and Unitary Operators,	3	K1 (R) K4(An)	Blended learning	Slip Test
	4.	Projections- Definition, preliminaries, Theorems on Projections and Theorems on invariant subspace	3	K2 (U) K4(An)	Brain Storming	Online Quiz
	5.	Spectral theory, Definition of Spectrum of an operator and spectral theorem	3	K1 (R) K4(An)	Lecture using videos	Home assignment
V	**General Preliminaries on Banach Algebras**					
	1.	The definition and some examples of Banach algebra	3	K1 (R) K2 (U)	Lecture with illustration	MCQ Using Nearpod
	2.	Theorems on Regular and Singular elements	4	K1 (R) K3(Ap)	Interactive PPT using Gamma AI	Class Test
	3.	The definition and theorems on spectrum	4	K1 (R) K4(An)	Evaluative Learning	Formative Assessment Test II

	4.	The formula and theorems on Spectral radius	4	K1 (R) K4(An)	Lecture using videos	Quizze

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

Activities(Em/En/SD) : 1. Evaluation through short test, Quiz competition

2. Peer teaching, Puzzles

Assignment: Preparation of quiz questions, Normal and Unitary Operators

Seminar Topic: Hilbert Space and Adjoint operator

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

Activities related to Cross Cutting Issues : Nil

Sample questions: (Minimum one question from each unit)

Part-A

1. Which of the following is not a property of norm in general?
   (a) $\|x\| \geq 0$
   (b) $\|x + y\| \leq \|x\| + \|y\|$
   (c) $\|kx\| = k\|x\|$
   (d) $\|x\| = 0$ iff $x = 0$

2. State the condition for a normed linear space N to be reflexive.

3.Consider the statements:

(i) A one-to-one linear transformation T of a Banach space onto itself is continuous then its inverse T^{-1} is automatically continuous.

(ii) A non-empty subset X of an normed linear space N is bounded iff f(x) is a bounded set of number for each f in N^*

a. Only (i) is true

b. Only (ii) is true

c. Both (i) and (ii) are true

d. Neither (i) nor (ii) are true.

4. 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) $\sqrt{2}$

5. .Choose the correct answer for the following norm $\|T^*T\|$ =

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

6. Give an example of a Banach Algebra

Part-B

1. For $1 \leq p \leq \infty$, prove that ${l_p}^n$ is a Banach space.
2. If P is a projection on a Banach space B and if M and N are its range and null space, then show that M and N are closed linear subspaces of B such that $B = M \oplus N$.
3. State and prove Schwartz inequality.
4. Show that if T is normal then each M_i reduces T.
5. State and prove closed graph theorem.
6. Prove that σ(x) is non-empty.

Part-C

1.If T is a linear transformation of N in to N^1. Then the following conditions on T are all equivalent to one another.

(i) T is continuous

(ii) T is continuous at the origin

(iii) there exists a real number K ≥ 0 with the property that $\|T(x)\| \leq K\|x\|$ for every $x \in N$.

(iv) If $S = \{x : \|x\| \leq 1\}$ is the closed unit sphere in N then its image T(S) is a bounded set in N.'

2.State and prove the open mapping theorem.

3. State and prove Bessel's inequality

4. State and prove the Uniform Boundedness Theorem

5. State and prove the spectral theorem.

6. Prove that r(x) = $\lim\|x^n\|^{1/n}$

Head of the Department
Dr.S.Kavitha

Course Instructor
Dr.S.Kavitha

Operations Research

Semester **: IV**

Name of the Course **: Operations Research**

Course code **: PM2043**

Major Core **: XIV**

CourseCode	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PM2023	5	1	-	-	5	6	90	25	75	100

Objectives:

1. To learn optimizing objective functions
2. To solve life oriented decision making problems

Course Outcomes

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	U
CO - 2	relate the concepts of Arrow (Network)diagram representations, in critical path calculations and construction of the Time chart	PSO - 3	U
CO - 3	distinguish deterministic model and single item	PSO - 3	E
CO - 4	interpret Poisson and Exponential distributions and apply these concepts in Queuing models	PSO - 4	Ap
CO - 5	solve life oriented decision making problems by optimizing the objective function	PSO - 1	C

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

Unit	Module	Topics	Teaching Hours	Cognitive Level	Pedagogy	Assessment/ Evaluation
I	**Elements of DP Model**					
	1	Elements of the DP Model, The Capital Budgeting Example	4	K1(R)	Lecture with Chalk and talk	Evaluation through shortTest
	2	More on thedefinitionofthe state	3	K2(U)	Lecture with Illustration	Formative assessment
	3	Examples of DP models and computation	3	K4(An)	Lecture Discussion	Evaluation through short test

	4	Solution of linear programming by dynamic programming	2	K4(An)	Lecture using videos	Assignment
	5	Gametheory	3	K3(Ap)	Lecture using PPT	Evaluation through quiz
II	**Arrow(Network) Diagram**					
	1	Introduction to Arrow(Network), Diagram Representations	3	K2(U)	Lecture with Illustration	Evaluation through short test
	2	Critical PathCalculations, Problem based on critical Path Calculations, Determination of floats	4	K3(Ap)	Lecture using PPT	Formative assessment
	3	Construction of theTimeChart and Resource Leveling, Problems based on Time Chart and Resource Leveling	4	K4(An)	Lecture with Chalk and talk	Evaluation through Seminar
	4	Probability and Cost Considerations in Project Scheduling	2	K4(An)	Lecture with Discussion	Evaluation through quiz
III	**Generalized Inventory Model**					
	1	Introduction to Generalised Inventory model, Types of Inventory Models	4	K2(U)	Lecture with Illustration, group discussion	Evaluation through short test
	2	Deterministic Models, Single Item Static Model, Problems based on Single Item Static Model	4	K4(An)	Lecture with PPT	Evaluation through Formative assessment
	3	Single Item Static, Model with Price Breaks, Problems based	3	K2(U)	Peer Teaching	Evaluation through quiz

		On Single Item, Static Model with Price breaks				
	4	Multiple-Item static Mode lwith Storage Limitations, Problems based on Multiple - Item static Model with Storage Limitations	2	K3(Ap)	Lecture with PPT	Evaluation through Assignment, Test
	5	Single–Item static Model with Storage Limitations	2	K3(Ap)	Lecture with Chalk and talk	Evaluation through short test
IV	**Queuing Model**					
	1	Basic Elements of the Queuing Model, Roles of Poisson Distributions, Roles of Exponential Distributions	3	K2(U)	Lecture with PPT	Evaluation through short test
	2	Arrival process, Examples of arrival process	2	K4(An)	Lecture using videos	Evaluation through t Formative Assessment
	3	Departure process, Queue with Combined Arrivals and Departure	3	K2(U)	Lecture with Illustration	Evaluation through short Quiz
	4	Problems based on Queue with Combined Arrivals and Departure	2	K3(Ap)	Lecture with Chalk and talk	Brain Storming
	5	Queuing Models of Type:(M/M/1): (GD/∞/∞), Problems based on: (M/M/1):(GD/∞/∞)	3	K4(An)	Lecture using PPT	Evaluation through Formative Assessment Test
	6	Queuing Models of Type (M/M/1): (GD/N/∞), Problems based on (M/M/1):(GD/N/∞)	3	K3(Ap)	Lecture with Discussion	Evaluation through short Quiz
V	**Types of Queuing Models**					

	1	Queuing Model(M/G/1): (GD/∞/∞), (M/M/C): (GD/∞/∞), The Pollaczek-Khintchine Formula	4	K2(U)	Lecture with Illustration	Evaluation through short
	2	Problems based on (M/M/C):(GD/∞/∞), (M/M/∞) :(GD/∞/∞) Self service Model	4	K3(Ap)	Lecture with Chalk and talk	Evaluation through assignment
	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	K4(An)	Lecture using PPT	Evaluation through assignment
	4	Tandem or series queues	3	K3(Ap)	Lecture using videos	Evaluation through assignment

Course Focussing on Employability/ Entrepreneurship/ Skill Development: Employability

Activities (Em/ En/SD): Problem-solving, Seminar Presentation, Group Discussion, Online Assignment, Open book test

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

Activities related to Cross Cutting Issues: -Nil

Assignment: Solving Exercise Problems

Seminar Topic: Introduction to Arrow(Network), Diagram Representations, Critical PathCalculations, Problem based on critical Path Calculations, Determination of floats

Sample questions

PART-A

1. The main difference between the forward and backward methods occur in the way we define the state of the system.True/False

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

3. The _____ is a penalty incurred when we run out of stock of a needed commodity.

4. In arrivals process, the solution of difference-differential equations is given by_____.

5. The measure of L_q in machine servicing model_____.

PART-B

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

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

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

3. Consider the inventory model with the following information.K=$10,h=$1,β=5 units,c1=$2,c2=$1and q=15 units.Compute y^* and the total cost per unit time.

4. Explain Kendal-LeeNotation

5. Explain (M/M/R): (GD/K/K) machine service model.

PART-C

1. 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

2. Explain PERT procedure.

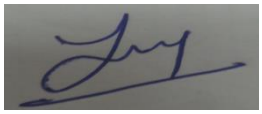
3. Consider a four period model with the following data

Period i	ξ_i	K_i
1	76	98
2	26	114
3	90	185
4	67	70

Find the optimal policy.

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

5. Derive the Pollaczek –KhintchineFormula.



Head of the Department | **Course Instructor**

Dr. S. Kavitha | **Dr. J. Nesa Golden Flower**

Algorithmic Graph Theory

Department : Mathematics (SF)
Class : II M.Sc. Mathematics (SF)
Title of the Course : Core XV: 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

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), K5 (E)

CO - 2	analyse 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 lectures, assignments and tests)

Unit	Module	Topics	Teaching Hours	Cognitive level	Pedagogy	Assessment/ Evaluation
I						
	1	Role of algorithms in computing- Algorithms, Data structures, Technique, Hard problems, Parallelism	4	K2 (U)	Introductory session, Lecture with illustration	Questioning, Recall steps, concept with examples
	2	Algorithms as a technology- Efficiency, Algorithms and other technologies	4	K4 (An)	Flipped classroom	Group discussion
	3	Insertion sort and its algorithm, Pseudocode conventions	3	K3 (Ap)	Lecture with illustration, Peer tutoring	Slip Test

	4	Analyzing Algorithms- Worst-case and average-case analysis	4	K4 (An)	PPT	Quiz using slido
	5	Designing Algorithms –The divide-and-conquer approach and its algorithm, Analysis of merge Sort	3	K4 (An)	Lecture Method	concept explanations
II						
	1	Representations of graphs – adjacency list representation, adjacency matrix representation	3	K1 (R)	Lecture using videos	Evaluation through short test
	2	Definitions and Breadth first Search algorithms, Shortest paths and related Lemmas, Corollary and correctness of breadth first Search theorem	3	K2 (U)	Flipped classroom	concept definitions, concept with examples
	3	Breadth-first trees, related Lemma, Definitions and Depth first search algorithms	4	K2 (U)	Blended learning	Quiz using Nearpod
	4	Parenthesis theorem, Corollary on nesting of descendant's intervals, White-path theorem	4	K3 (Ap)	Context based	Slip Test, Quiz using google forms
	5	Topological Sort, Strongly Connected Components and related Lemmas and Theorems	4	K3 (Ap)	Reflective Thinking	Brainstorming, Formative Assessment I

III						
	1	Theorem, Corollary related to Growing a minimum spanning tree	4	K2 (U)	Demonstrative	concept with examples, Questioning
	2	Kruskal's algorithm	4	K2 (U)	Lecture Method	Evaluation through short test
	3	Prim's algorithm, The execution of Prim's algorithm on the graph	5	K3 (Ap)	PPT	Group discussion
	4	Problems based on minimum spanning tree	5	K5 (E)	Problem solving	concept explanations
IV						
	1	Single- source shortest paths, Lemma and Corollary based on correctness of the Bellman-Ford algorithm	3	K4 (An)	Introductory session	concept with examples, Assignment
	2	Theorem and definition related to Single-source shortest paths in directed acyclic graphs	4	K2 (U)	Context based	concept explanations, Quiz using Slido
	3	Dijkstra's algorithm, correctness of Dijkstra's algorithm theorem	3	K4 (An)	Brainstorming	concept explanations, Evaluation through short test
	4	Corollary and analysis of Dijkstra's algorithm	4	K4 (An)	Brainstorming	Slip Test

	5	Difference constraints and shortest paths, Systems of difference Constraints, Constraint graphs	4	K2 (U)	Lecture Method	Group discussion
V						
	1	Computing the shortest-path weights bottom up algorithm	3	K5 (E)	Problem solving	concept with examples, Seminar
	2	Algorithm for matrix multiplication, Improving the running time and technique of repeated squaring	4	K2 (U)	Demonstrative	Slip Test, Seminar
	3	The structure of a shortest path, A recursive solution to the all-pairs shortest paths problem	4	K3 (Ap)	Demonstrative	Oral Test, Seminar
	4	Computing the shortest-path weights bottom up, Transitive closure of a directed graph algorithm	4	K5 (E)	Computational thinking	Quiz using google forms, Seminar
	5	Johnson's algorithm for sparse graphs- Preserving shortest paths by reweighting and related Lemma	3	K2 (U)	Lecture Method	Quiz using Mentimeter, Formative Assessment II

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

Activities (Em/ En/SD): Solve practical problems in networking and communication

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

Activities related to Cross Cutting Issues: Nil

Assignment: Single source shortest paths

Seminar Topic: All pairs shortest paths

Sample questions

Part A

1. For merge sort, we use _____approach.
2. Say true or false:

   BFS runs in time linear in the size of the adjacency-matrix representation of *G*.
3. If T is acyclic and connects all of the vertices then the tree is called _____.
   (a) connected tree (b) spanning tree
   (c) minimum tree (d) minimum spanning tree
4. The running time of Dijkstra's algorithm is _____.
5. Define predecessor subgraph of *G*.

Part B

1. Describe about hard problems.
2. Analyze the running time of DFS.
3. Write Prim's algorithm.
4. Explain three variants of single-source shortest paths.
5. Write square matrix multiplication algorithm and find the running time of the algorithm.

Part C

1. Describe about analysis of merge sort.
2. State and prove Parenthesis theorem.
3. Explain Kruskal's algorithm with an illustration.
4. State and prove the correctness of Bellman-Ford algorithm.

5. Explain about computing all-pairs shortest paths using Johnson's algorithm with an example.

Head of the Department: Dr.S.Kavitha **Course Instructor: Dr.C.Jenila**

Combinatorics

Department : **Mathematics**

Class : **I M.Sc. Mathematics**

Title of the Course : **Elective IV (a) - Combinatorics**

Semester : **IV**

Course code : **PM2045**

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PM2045	5	1	-	-	4	6	90	40	60	100

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

2. Solve related real life problems.

Course Outcomes

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	K2

CO - 2	Distinguish between permutation and combination, distribution of distinct and non-distinct objects	PSO - 2	K4
CO - 3	Correlate recurrence relation and generating function	PSO - 2	K4
CO -4	Solving problems by the technique of generating functions, combinations, recurrence relations, the principle of inclusion and exclusion	PSO - 3	K3
CO - 5	Interpret the principles of inclusion and exclusion, equivalence classes and functions	PSO - 4	K4, K5
CO - 6	Develop the concepts of Polya's fundamental theorem and apply in Polya's theory of counting	PSO - 4	K5

Total contact hours: 75 (Including assignments and tests)

Unit	Module	Topic	Teaching Hours	Cognitive level	Pedagogy	Assessment Evaluation
I	**Permutations and combinations**					
	1.	Permutations and combinations	1	K2,K4	Lecture with Illustration	Questioning
	2.	The Rules of sum and product	2	K2	Lecture	Quiz using slido
	3.	Permutations	4	K2,K4	PPT	Problem Solving
	4.	Combinations	4	K2,K4	PPT	Assignment – exercise problems
	5.	Distribution of Distinct Objects and Distribution of Non distinct Objects	4	K4	Lecture	Slip test
II	**Generating Functions**					
	1.	Generating Functions	4	K3,K4	Lecture	Q & A

	2.	Generating Functions for Combinations	4	K3,K4	Lecture using PPT	Questioning
	3.	Enumerators for Permutations.	4	K2, K4	Lecture with Illustration	Problem Solving
		Distribution of distinct objects into non distinct cells	1	K4	Lecture with Illustration	Assignment – exercise problems
		Partitions of integers	1	K4	Lecture	Slip test
		The Ferrers graph	1	K4	Lecture with Illustration	Q & A
III	**Recurrence Relations**					
	1.	Recurrence Relations	5	K3,K4	Lecture	Multiple choice questions using nearpod
	2.	Linear Recurrence Relations with Constant Coefficients	5	K3,K4	Lecture	Assignment – Solving Exercise problems
	3.	Solution by the Technique of Generating Functions	5	K3, K4	Lecture with illustration	Short test
IV	**The Principle of Inclusion and Exclusion**					
	1.	The Principle of Inclusion and Exclusion	1	K4, K5	Lecture	Problem solving
	2.	The General Formula	1	K4, K5	Lecture	Q&A
	3.	Derangements	5	K4, K5	Lecture with Illustration	Quiz
	4.	Permutations with Restrictions on Relative Positions	4	K4, K5	Lecture	Solving Exercise problems

	5.	The Rook Polynomials	4	K4, K5	PPT	Solving Exercise problems
V	**Polya's Theory of Counting**					
	1.	Polya's Theory of Counting	1	K5	Lecture with Illustration	Short test
	2.	Equivalence Classes under a Permutation Group	5	K4, K5	Seminar presentation	Quiz using slido
	3.	Equivalence classes of Function	4	K4, K5	Seminar presentation	Short test
	4.	Weights and Inventories of Functions	4	K5	Seminar presentation	Explain concepts
	5.	Polya's Fundamental Theorem.	1	K5	Seminar presentation	Questioning

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

Activities (Em/ En/SD): Problem-solving, Seminar Presentation, Quiz Competition

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

Activities related to Cross Cutting Issues: -Nil

Assignment: Solving Exercise Problems

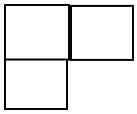
Seminar Topic: Polya's Theory of Counting, Equivalence Classes under a Permutation Group, Equivalence classes of Function, Weights and Inventories of Functions, Polya's Fundamental Theorem.

Sample Questions:

Part A

1. Say true or false: The number of ways of arranging 2 objects out of 3 objects is 3.

2. The generating function of the sequence 2,2,2,2,2. is _____
3. The Homogeneous solution of the complex roots is _____
4. The rook Polynomial for the following piece of chessboard is _____



5. Give a permutation group of the set { a, b,c }

Part –B

1.Among the 10 billion numbers between 1 and 10,000,000,000 how many of them

contain the digit 1? How many of them do not?

2. Evaluate $\sum_{i=0}^{t}\left(\binom{2i}{i}\binom{2t-2i}{t-i}\right)$

3. Solve the recurrence relation for the Fibonacci sequence of numbers.

4. Find the number of permutations of the letters a,b,c,d,e & f in which neither the pattern ace nor the pattern fd appears.

5. Find all the possible ways of painting three distinct balls in solid colors when there are three kinds of paint available an expensive kind of red paint, a cheap kind of red paint and blue paint.

Part –C

1. **(i)** 11 scientists are working on a secret project .They wish to lock up the documents in a cabinet such that the cabinet can be opened iff six or more of the scientists are present .what is the smallest number of locks needed? What is the smallest number of keys to the locks each scientist must carry?

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

2. (i) What is the ordinary enumerator for the selection of r objects out of n objects with unlimited repetitions?

(ii) .Find the number of r-digit quaternary sequences in which each of the digit 1,2,3 appears at least once?

3. Explain the Tower of Hanoi Problem and solve the corresponding Recurrence relation.

4.Twelve balls are painted in the following way ,2 are painted red, one is painted blue &one is painted white ,two are painted in red &blue and one is painted red& white, three are painted red ,blue ,white .Find the number of balls which are unpainted. find s_1,s_2,s_3 and e_1,e_2,e_3.

5. State and Prove Polya's theorem

Head of the Department

Dr. S.Kavitha

Course Instructor

Mrs.J.Anne Mary Leema