Holy Cross College (Autonomous), Nagercoil – 629004
Kanyakumari District, Tamil Nadu.
Nationally Accredited with A+ by NAAC IV cycle – CGPA 3.35

Affiliated to

Manonmaniam Sundaranar University, Tirunelveli

DEPARTMENT OF MATHEMATICS (SF)

SYLLABUS FOR POSTGRADUATE PROGRAMME

TEACHING PLAN

ODD SEMESTER 2024 - 2025

Vision

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

Mission

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

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

POs	Upon completion of M.Sc. Degree Programme, the graduates will be able to:	Mappingwith 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
PEO3	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

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

Department : Mathematics (SF)
Class : I M.Sc. Mathematics (SF)
Title of the Course : Core I: Algebraic Structures
Semester : I
Course Code : MP231CC1

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP231CC1	5	2			5	7	105	25	75	100

Learning Objectives

1. To introduce the concepts and to develop working knowledge on class equation, solvability of groups.
2. To understand the concepts of finite abelian groups, linear transformations, real quadratic forms

Course outcomes

CO	Upon completion of this course, the students will be able to:	PSO addressed	Cognitive level
CO - 1	recall basic counting principle, define class equations to solve problems, explain Sylow's theorems and apply the theorem to find number of Sylow subgroups.	PSO - 1	K1 (R)
CO - 2	define Solvable groups, define direct products, examine the properties of finite abelian groups, define modules	PSO - 2	K2 (U)
CO - 3	define similar Transformations, define invariant subspace, explore the properties of triangular matrix, to find the index of nilpotence to decompose a space into invariant subspaces, to find invariants of linear transformation, to explore the properties of nil potent transformation relating nilpotence with invariants.	PSO - 3	K3 (Ap)
CO - 4	define Jordan, canonical form, Jordan blocks, define rational canonical form, define companion matrix of polynomial, find the elementary devices of transformation, apply the concepts to find characteristic polynomial of linear transformation.	PSO - 3	K3 (Ap) K4 (An)
CO - 5	define trace, define transpose of a matrix, explain the properties of trace and transpose, to find trace, to find transpose of matrix, to prove Jacobson lemma using the triangular form, define symmetric matrix, skew symmetric matrix, adjoint to define Hermitian, unitary, normal transformations and to Evaluate whether the transformation in Hermitian, unitary and normal	PSO - 4	K5 (E)

Total Contact hours: 105 (Including lectures, assignments and tests)

Unit	Module	Topics	Teaching Hours	Cognitive level	Pedagogy	Assessment/ Evaluation
I						
	1	Another Counting Principle – Definition of conjugate and normalizer, Lemma on conjugacy and normalizer.	4	K1 (R) K2 (U)	Introductory session, Lecture with illustration	Questioning, recall steps, concept definitions, concept with examples
	2	Theorems and Corollary on conjugate class, problems of another counting principle	5	K5 (E)	Group discussion, Lecture with illustration, Problem solving	Evaluation through short test, concept explanations, solve problems
	3	First part of Sylow's Theorem- First proof, Corollary and Lemma on p-Sylow subgroup.	4	K3 (A)	Lecture with illustration, Peer tutoring	Slip Test, concept explanations
	4	Second and Third part of Sylow's Theorem, problems of Sylow's Theorem	5	K5 (E)	Lecture with illustration, PPT, Problem solving	Quiz using slido, concept explanations, solve problems
II						
	1	Direct Products- Definition of internal direct product, Lemma and Theorem on internal direct product, problems on direct products	4	K2 (U) K5 (E)	Introductory session, Lecture with illustration, Problem solving	Recall steps, questioning, concept definitions, concept with examples, solve problems
	2	Finite Abelian Groups- Theorem based on direct product of cyclic groups.	4	K3 (A)	Lecture with illustration, Group discussion	Group discussion, concept explanations, Quiz using Nearpod
	3	Modules-Definition and Examples, Definition of direct sum of submodules and cyclic R-module, Theorem and Corollary	5	K2 (U)	Lecture with illustration	concept definitions, concept with examples

		based on direct sum of submodules.				
	4	Solvability by Radicals- Definition on solvable, Lemma and Theorem on solvable, problems on solvability by radicals	5	K5 (E)	Lecture with illustration, Problem solving	concept definitions, concept with examples, oral test, solve problems
III						
	1	Triangular Form- Definition of similar and invariant, Lemma on invariant	4	K2 (U)	Lecture with illustration	concept definitions, concept with examples, questioning, Group discussion
	2	Theorems on triangular, problems on triangular form	4	K5 (E)	Lecture with illustration, Peer tutoring, problem solving	concept explanations, evaluation through short test, solve problems
	3	Nilpotent Transformations- Definition of index of nilpotence, invariant and cyclic, Lemma based on nilpotent, invariant	5	K3 (A)	Lecture with illustration, Group discussion	concept definitions, concept explanations, Quiz using Mentimeter
	4	Theorems based on index of nilpotence, similar, invariants	5	K3 (A)	Lecture with illustration, PPT	concept explanations, Brainstorming, slip test
IV						
	1	Jordan Form – Definition, Lemma and Corollary on minimal polynomial	4	K2 (U)	Lecture with illustration	concept definitions, concept with examples, Assignment
	2	Theorems and Corollary based on invariant, minimal polynomial, Jordan block, problems on Jordan Form	5	K5 (E)	Lecture with illustration, Peer tutoring, problem solving	concept explanations,Quiz using Kahoot, solve problems
	3	Rational Canonical Form- Definition of companion	4	K3 (A)	Lecture with illustration	concept explanations,Evaluation through short test

		matrix, Lemma on companion matrix				
	4	Definition of rational canonical form, elementary divisors, characteristic polynomial, Theorems based on elementary divisors, similar	5	K2 (U)	Lecture with illustration, Group discussion	concept definitions, concept explanations, Brainstorming
V						
	1	Trace and Transpose-Definition, Lemma and Corollary based on trace, nilpotent, transpose	4	K2 (U)	Introductory session, Lecture with illustration	concept explanations, concept definitions, concept with examples
	2	Hermitian, Unitary and Normal Transformations-Definition, Lemma on unitary, Hermitian adjoint, normal	4	K3 (A)	Lecture with illustration	concept definitions, concept explanations, slip test, seminar
	3	Theorems based on unitary, Hermitian, normal, problems on Hermitian	5	K5 (E)	Lecture with illustration, problem solving	concept explanations, Quiz using Quizizz, solve problems, seminar
	4	Real Quadratic Forms-Definition, Lemma and Theorem on congruent	5	K3 (A)	Lecture with illustration	concept definitions, Evaluation through short test, seminar

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

Activities (Em/ En/SD): Group discussion

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

Activities related to Cross Cutting Issues: Nil

Assignment: Jordan Form

Seminar Topic: Hermitian, Unitary and Normal Transformations

Sample questions

Part A

1. If a∈G then the normalizer of a in G, is the set N(a) = ______.
2. An R-module M is said to be _______ if there is an element m0∈M such that every m∈M is of the form m=rm0 where r∈R.
   a.Finitely generated (b) cyclic (c) direct sum (d) unital
3. State True or False: The subspace W of V is invariant under T∈A(V) if WT W.
4. If dimFV=n then the _______ of T, is the product of its elementary divisors.
   (a) characteristic polynomial (b) companion matrix
   (c) rational canonical form (d) similar
5. Two real symmetric matrices A and B are ________ if there is a nonsingular real matrix T such that B=TAT'.

Part B

1. Prove that N(a) is a subgroup of G.
2. Prove that G is solvable if and only if Gk=(e) for some integer k.
3. If M of dimension m is cyclic with respect to T then prove that the dimension of MTk is m-k for all k≤m.
4. Suppose that V=V1V2 where V1 and V2 are subspaces of V invariant under T. Let T1 and T2 be the linear transformations induced by T on V1 and V2 respectively. If the minimal polynomial of T1 over F is p1(x)while that of T2is p2(x) then prove that the minimal polnomial for T over F is the least common multiple of p1(x) and p2(x).
5. If T∈A(V) then tr T is the sum of the characteristic roots of T.

Part C

1. Prove that the number of p-Sylow subgroups in G, for a given prime, is of the form 1+kp.
2. Prove that every finite abelian group is the direct product of cyclic groups.
3. If T∈A(V) has all its characteristic roots in F then prove that there is a basis of V in which the matrix of T is triangular.
4. Prove that the elements S and T in AF(V) are similar in AF(V) if and only if they have the same elementary divisors.
5. Prove that the linear transformation T on V is unitary if and only if it takes an orthonormal basis of V into an orthonormal basis of V.

Teaching Plan

Department :**Mathematics**

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

Title of the Course : Core Course II Real Analysis I

Semester : **I**
Course Code : **MP231CC2**

Course Code	L	T	P	Credits	Inst. Hours	Total Hours	Marks		
							CIA	External	Total
MP231CC2	**5**	**2**	**-**	**5**	**7**	**105**	**25**	**75**	**100**

Learning Objectives:

To work comfortably with functions of bounded variation, Riemann- Stieltjes Integration, convergence of infinite series, infinite product and uniform convergence.

1. To relate its interplay between various limiting operations

Course outcomes

CO	Upon completion of this course, the students will be able to:	PSO addressed	Cognitive level
CO - 1	analyze and evaluate functions of bounded variation and rectifiable Curves.	PSO - 1	K4, K5
CO - 2	describe the concept of Riemann-Stieltjes integrals and its properties.	PSO - 2	K1, K2
CO - 3	demonstrate the concept of step function, upper function, Lebesgue function and their integrals.	PSO - 2	K3
CO - 4	construct various mathematical proofs using the properties of Lebesgue integrals and establish the Levi monotone convergence theorem.	PSO - 4	K3, K5

CO - 5	formulate the concept and properties of inner products, norms and measurable functions.	PSO - 2	K2, K3

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

Unit	Module	Topic	Teaching Hours	Cognitive level	Pedagogy	Assessment/ Evaluation
I	**Functions of Bounded Variation, Infinite Series**					
	1.	Definition of monotonic function connected and disconnected functions compact sets and examples	2	K1, K2	Brainstorming	Questioning
	2.	Properties of monotonic functions, Functions of bounded variation, Definition - Partition, Bounded variation, Examples of continuous functions that are not of bounded variation, Illustration on boundedness of f' is not necessary for f to be of bounded variation	4	K4, K5	Lecture with illustration	Class test
	3.	Total variation – Definition, Behaviour of functions of bounded variation, Example illustrating reciprocal of functions of total variation need not be of total variation, Additive property of total variation	4	K2, K5	Illustrative Method	Slip test
	4.	Total variation on [a,x] as a function of the right end point x, Functions of bounded variation expressed as the difference of increasing functions – Characterization of functions of bounded variation, Continuous	4	K2, K5	Lecture	Quiz using Slido

		functions of bounded variation				
	5.	Absolute and Conditional convergence, Definition – Absolutely convergent series, Example illustrating convergence does not imply absolute convergence, Dirichlet's test and Abel's test	3	K2, K4	Illustrative method and Discussion	Slip test
	6.	Rearrangement of series, Riemann's theorem on conditional convergent series	3	K4	Lecture	Class test
II	**The Riemann - Stieltjes integral**					
	1.	The Riemann - Stieltjes integral – Introduction, Basics of calculus, Notation, Definition – refinement of partition, norm of a partition, The definition of The Riemann - Stieltjes integral, integrand, integrator, Riemann integral	4	K1	Brainstorming	Slip test
	2.	Linear properties of Riemann - Stieltjes integral, Integration by parts, Connection between integrand and the integrator in a Riemann – Stieltjes integral	3	K2	Discussion and Lecture	Quiz
	3.	Change of variable in a Riemann – Stieltjes integral, Reduction to a Riemann integral, Step functions as integrators, Example showing that the existence of integral can also be affected by a change	4	K2	Flipped Classroom	Presentation

	4.	Reduction of a Riemann – Stieltjes integral to a finite sum, Definition - Step function, Euler’s Summation formula, Monotonically increasing integrators, upper and lower integrals, Definition – upper	4	K2	Lecture	Quiz method

		and lower Stieltjes sums of *f* with respect to α for the partition P, Theorem illustrating for increasing α, refinement of partition increases the lower sums and decreases the upper sums				
	5.	Definition – Upper and lower Stieltjes integral, upper and lower Riemann sums, Examples, Additive and linearity properties of upper and lower integrals, Riemann’s condition, Comparison theorems	4	K2	Illustration method	MCQ
III	**The Riemann - Stieltjes integral**					
	1.	Integrators of bounded variation, Sufficient conditions for existence of Riemann – Stieltjes integrals	3	K2	Lecture	Short test
	2.	Necessary conditions for existence of Riemann – Stieltjes integrals, Theorem illustrating common discontinuities from the right or from the left, Mean - value theorems for Riemann – Stieltjes integrals – first mean – value theorem, second mean – value theorem, the integral as a function of the interval and its properties	4	K3, K4	Lecture with illustration	Assignment

	3.	Second fundamental theorem of fundamental calculus, Change of variable in a Riemann integral, Second Mean – Value theorem for Riemann integrals	4	K3, K4	Lecture	Short test
	4.	Riemann – Stieltjes integrals depending on a parameter, Differentiation under the integral sign	4	K3, K5	Lecture	Questioning

	5.	Interchanging the order of integration, Lebesgue's criterion for existence of Riemann integrals, Definition – measure zero, examples, Definition – oscillation of f at x, oscillation of f on T, Lebesgue's criterion for Riemann integrability	4	K4	Interactive method	Slip Test
IV	**Infinite Series and Infinite Products, Power Series**					
	1.	Double sequences, Definition – Double sequence, convergence of double sequence, Example, Definition – Uniform convergence, Double series, Double series and its convergence, Rearrangement theorem for double series, Definition – Rearrangement of double sequence	3	K1 & K2	Brainstorming PPT	Quiz
	2.	A sufficient condition for equality of iterated series, Multiplication of series, Definition – Product of two series, Conditionally convergent series, Cauchy product, Merten's Theorem, Dirichlet product	5	K3	Lecture	MCQ

	3.	Cesaro Summability, Infinite products, Definition – infinite products, Cauchy condition for products	4	K2	Lecture	Concept Explanation
	4.	Power series, Definition – Power series, Multiplication of power series, Definition – Taylor's series	3	K3, K4	Lecture with chalk and talk	Slip Test
	5.	Abel's limit theorem, Tauber's theorem	3	K2, K4	Lecture Discussion	Q & A
V	**Sequences of Functions**					
	1.	Sequences of function – Pointwise convergence of sequence of function, Examples of sequences of real valued functions	3	K2	Introductory Session	Quiz using Quizizz

2.	Uniform convergence and continuity, Cauchy condition for uniform convergence	4	K2, K4	Lecture with illustration	Concept explanation
3.	Uniform convergence of infinite series of functions, Riemann – Stieltjes integration, Non-uniform convergence and term-by-term integration	3	K3, K4	Seminar Presentation	Questioning
4.	Uniform convergence and differentiation, Sufficient condition for uniform convergence of a series, Mean convergence	4	K2	Seminar Presentation	Recall steps

Course Focussing on Skill Development

Activities (Em/ En/SD): Assignment, 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: Double Sequence, Double Series, Rearrangement theorem for Double series, Sequence of functions- Pointwise, Uniform convergence

Sample questions

Part A

1. State True or False: The set of discontinuities of f is uncountable, if f is monotonic on [a,b]
2. Riemann integral is a special case of Riemann Stieltjes integral when $(x) =$ ____.

3.Vfa,b=0 if and only if f is …………….. on a,b.
4.Define a double sequence.

5.A sequence of functions $\{f_n\}$ is said to be___on T if $\{f_n\}$ is pointwise convergent and uniformly bounded on T.

Part B

1. If f is monotonic on [a,b], then prove that f is of bounded variation on a,b.

2.Prove that the Riemann Stieltjes integral operates in a linear fashion on the integrator.

3.Prove that if f is continuous on [a,b] and if α is of bounded variation on [a,b], then $f \in R(\alpha)$ on [a,b].

4.Assume that we have fx=n=0anxn, if-r<x<r. If the series also converges at x=r, then the limit f(x) exists and we have f(x) =n=0anrn.

5.State and prove Dirichlet's test for uniform convergence.

Part C

1. Assume that f and g are each of bounded variation on [a,b]. Then Show that their sum difference and product are also of bounded variation.
   Also Vf+gVf+Vg and Vf.g≤AVf+BVg where A=sup{gx:x∈a,b}, B=sup{fx:x∈a,b}

2.State and prove the formula for Integration by parts.

3.Assume that α is of bounded variation on [a,b]. Let V(x) denote the total variation of α on [a,x] if $a <$x$\leq b$, and let V(a)=0. Let f be defined and bounded on [a,b]. If $\in (\alpha)$ on [a,b], then prove that $\in R(V)$ on [a,b].

4.Let an be a conditionally convergent series with real valued terms. Let x and y be given numbers in the closed interval [-∞,∞] with ≤y . Then show that there exists a rearrangement bn and an such that inf tn =x and sup tn =y where tn=b1+.........+bn.

5. Assume that each term of $\{fn\}$ is a real-valued function having a finite derivative at each point of an open interval (a,b). Assume that for at least one point x_0 in (a,b) the sequence $f_n(x_0)$ converges. Assume further that there exists a function g such that $f_n' \longrightarrow g$ uniformly on (a,b). Then prove that

a. There exists a function f such that $f_n \longrightarrow f$ uniformly on (a,b).

b.For each x in (a,b) the derivative$f'(x)$ exists and equals g(x).

Teaching Plan

Department : Mathematics
Class : I M.Sc
Title of the Course : Major Core III: Ordinary Differential Equations
Semester : I
Course Code : MP241CC3

Course Code	L	T	P	Credits	Inst. Hours	Total Hours	Marks		
							CIA	External	Total
PM2031	5	1	-	5	6	90	25	75	100

Learning Objectives

1. To develop proficiency in solving second order linear ordinary differential equations, including homogeneous and non-homogeneous forms.
2. To solve systems of first- order linear differential equations with constant coefficients, understanding the existence and uniqueness of solutions.

Course outcomes

CO	Upon completion of this course, the students will be able to:	PSO addressed	Cognitive level
CO - 1	recall and describe the fundamental concepts of second-order linear ordinary differential equations, including homogeneous and non-homogeneous forms.	PSO-1	**K1**
CO - 2	understand the method of variation of parameters for solving non-homogeneous second-order linear differential equations and illustrate its application through examples.	PSO-2	**K2**
CO - 3	apply power series solutions to solve first and second-order linear ordinary differential equations, distinguishing between ordinary points and regular singular points.	PSO-4	**K3**
CO - 4	analyze the stability and behavior of solutions for systems of first-order linear differential equations with constant coefficients, identifying critical points and their implications.	PSO- 2	**K4**
CO - 5	utilize special functions such as Legendre polynomials and Bessel functions to solve differential equations and evaluate their effectiveness in addressing specific mathematical and physical problems.	PSO-5	**K5**

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

Unit	Module	Topic	Teaching Hours	Cognitive level	Pedagogy	Assessment/ Evaluation
I	**Second order homogeneous equations**					
	1.	Second order homogeneous equations	3	K1 & K2	Brainstorming	MCQ

	2.	The general solution of a homogeneous equation	3	K2	Lecture	Slip Test
	3.	The use of a known solution to find another	3	K3	Lecture Discussion	Questioning
	4.	The method of variation of parameters	3	K1 & K3	Lecture	Questioning
	5.	Problems on the method of variation of parameters	3	K4	Problem Solving	Class test
II	Power series solutions and special functions					
	1.	Power series solutions and special functions	3	K1	Lecture with Illustration	Questioning
	2.	A review of power series	3	K2	Problem solving	Short summary
	3.	Series solutions of first-order equations	3	K3	Brain storming	Concept definitions
	4.	Second-order linear equations	3	K5	Lecture with Problem solving	Recall steps
	5.	Ordinary points - Regular singular points.	3	K1	Problem solving	MCQ
III	Systems of first-order equations					
	1.	Systems of first-order equations	4	K1 & K2	Brainstorming	Quiz
	2.	Linear systems	3	K3	Lecture	Explain
	3.	Homogeneous Linear systems with constant coefficients.	4	K6	Lecture Discussion	Slip Test
	4.	Problems on Homogeneous Linear systems with constant coefficients.	4	K4	Lecture	Questioning
IV	Legendre polynomials					
	1.	Legendre polynomials	3	K1 & K2	Brainstorming	Quiz
	2.	properties of Legendre polynomials	3	K5	Lecture Discussion	Differentiate between various ideas
	3.	Bessel’s functions	3	K3	Lecture method	Explanations
	4.	The Gamma functions	3	K1 & K2	Problem solving	Slip Test
	5.	Properties of Bessel Functions.	3	K3	Lecture method	Explanations
V	1.	The Existence and Uniqueness of solutions	3	K1 & K2	Brainstorming	MCQ

	2.	The Method of Successive Approximations	3	K4	Lecture	Concept explanations
	3.	Picard's theorem	3	K1 & K2	Problem solving	Questioning
	4.	Systems of the second order linear equations.	2	K4	Lecture	Recall steps
	5.	Problems on Systems of the second order linear equations.	4	K1 & K2	Lecture	True/False

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

Activities (Em/ En/SD): **Group Discussion**

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

Activities related to Cross Cutting Issues: -

Assignment: Exercise Problems in the Method of successive approximations

Sample questions (minimum one question from each unit)

Part A

Answer all the questions:

1. If R(x)=0 in $y'' + P(x)y' + Q(x)y = R(x)$ then the equation is called ___.
2. The wronskian of y_1 and y_2 is given by_.
3. The binomial series expansion is given by $(1 + x)^p$ =___
4. Any point that is not an ordinary point of $y'' + (x)y' + Q(x)y = 0$ is called a______________.

a. Regular singular point b) Singular point

c)Fixed point d) Irregular singular point

5. If two solutions of the homogeneous Linear system of equations are linearly independent on [a, b] and if { xp(t),yp(t) } is any particular solution , what is the general solution of the non-homogeneous linear system of equations?
6. The auxiliary equation for the system dx/dt=3x-y & dx/dt=x-y is__________
7. Give an example of a irregular singular point.
8. The value of Γ(1) is _________
9. **State True/ False**. The solution of $y' = 3y^{2/3}$, $y(0) = 0$ and let R be the rectangle $|x| \leq 1, |y| \leq 1$ is unique.
10. Picard's theorem is called a__because it guarantees the existence of a unique solution only on some interval $|x - x_0| \leq h$ where h may be very small.

Part-B

Answer all the questions:

11. If $y_1(x)$, $y_2(x)$ are any two solutions of the homogeneous equation then show that $c_1y_1(x)+ c_2y_2(x)$ is also is a solution for any constants c_1 and c_2.
12. Find the particular solution of y”+y = cosecx.
13. Solve the differential equation $y' = y$ by power series method.
14.Solve the D.E $y''+y = 0$ in terms of power series.
15. Solve the system of equations dxdt=x+y & dydt=4x-2y
16. Solve the system of equations dxdt=2x & dydt=3y
17. Prove that $P_n(1) = 1$, $P_n(-1) = (-1)^n$.

18. Find the first three terms of the Legendre’s series of fx=ex

19. Derive Picard’s iteration formula for the initial value problem y'=fx,y, $y(x_0) = y_0$ where f(x, y) is an arbitrary function defined and continuous in some neighbourhood of the point (x_0, y_0).
20. Calculate $y_1(x)$, $y_2(x)$, $y_3(x)$ for $y' = 2(1 + y)$, $y(0) = 1$

Part C

Answer all the questions:

21. Show that $y = c_1 \sin x + c_2 \cos x$ is the general solution of y”+y = 0 on any interval and find the particular solution for which y(0) = 2 and y’(0) = 3
22. Explain the method of using a known solution to find another solution.
23. Solve the differential equation by the method of power series to obtain the power series expansion for (1+x)p
24. Solve the Hermite's equation by power series method.
25. Find the solution of the homogeneous system dxdt=5x+4y & dydt=-x+y
26. Find the solution of the homogeneous system dxdt=4x-2y & dydt=5x+2y

27. Prove that 12=
28. Solve Bessel’s equation is $x^2y'' + xy' + x^2y = 0$
29. State and prove Picard’s theorem.
30. Let f(x,y) be a continuous function that satisfies the Lipschitz condition
fx,y1-f(x,y2≤Ky1-y2 on the strip by a≤x≤b and -∞<y<∞. If f(x0,y0)
is any point on the strip then prove that the initial value problem y'=fx,y, yx0=y0
has one and only solution y=y(x) on the interval a≤x≤b.

Teaching Plan

ELECTIVE COURSE I: a) NUMBER THEORY AND CRYPTOGRAPHY

Class : **I M.Sc Mathematics**

Title of the course :**ELECTIVE I- Number Theory and Cryptography**

Semester : **I**

Name of the Course : **Number Theory and Cryptography**

Course code : **MP231EC1**

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP231EC1	4	1	-	-	3	5	75	25	75	100

Learning Objectives:

1. To gain deep knowledge about Number theory.
2. To know the concepts of Cryptography.

Course outcomes

CO	Upon completion of this course, the students will be able to:	PSO addressed	Cognitive level
CO - 1	understand quadratic and power series forms and Jacobi symbol	PSO - 1	**K1 & K2**
CO - 2	apply binary quadratic forms for the decomposition of a number into sum of sequences	PSO - 2	**K3**
CO - 3	determine solutions using Arithmetic Functions.	PSO - 3	**K3**
CO - 4	calculate the possible partitions of a given number and draw Ferrer's graph.	PSO - 3	**K4**
CO - 5	identify the public key using Cryptography.	PSO - 2	**K5 & K6**

Unit	Module	Topics	Teaching Hours	Cognitive level	Pedagogy	Assessment /Evaluation
I						
	1	Divisibility and Euclidean algorithm	4	K1(R) K2(U)	PPT using Gamma	Recall basic definitions
	2	Congruences, Euler's theorem	3	K3(Ap)	Lecture with Illustration	Class Test
	3	Wilson's Theorem	4	K2(U)	Flipped Classroom	MCQ
	4	Chinese Remainder Theorem, Primitive roots	4	K3(Ap)	Blended Classroom	SlipTest
II						
	1	Quadratic Residues	5	K2(U)	Interactive PPT	Questioning
	2	Quadratic Reciprocity	3	K3(Ap)	Lecture with Illustration	Oral Test
	3	The Jacobi Symbol	3	K4(An)	Flipped Classroom	Online Quiz using Slido
III						
	1	Arithmetic functions	5	K4(An)	Lecture using videos	Solving problems
	2	The Mobius Inversion Formula	4	K3(Ap)	Flipped classroom	MCQ using Nearpod
	3	Multiplication of arithmetic functions.	3	K3(Ap)	Blended learning	Formative Assessment Test I

IV						
	1	Linear Diophantine equations	3	K4(An)	Lecturewith Illustration	Oral Test
	2	Sum of Four and Five Squares	4	K3(Ap)	Computational learning	Short summary
	3	Sum of Fourth Powers	3	K3(Ap)	Flipped Classroom	Evaluation through online quiz
	4	Sum of Two Squares.	2	K3(Ap)	Problem solving	Recall steps
V						
	1	Public key Cryptography	5	K5(E)	Lecture using videos	Recall basic definitions
	2	Concepts of public key Cryptography	3	K5(E)	Experimental learning	Evaluation through online Quiz
	3	Modular arithmetic and RSA	3	K6(C)	Problem solving	Formative Assessment Test I
	4	Discrete logarithm and Elliptic curve Cryptography	4	K6(C)	Lecture using chalk and talk	Slip test

Course Focussing on Employability/ Entrepreneurship/ Skill Development : Skill DevelopmentActivities (Em/ En/SD): Quiz Competition, 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 : Quadratic Residues problems and Sum of Fourth Powers

Seminar Topic: Public key Cryptography and Discrete logarithm and Elliptic curve Cryptography

Sample questions

Part A

1. State Wilson's theorem

2. The form f(x, y) = $x^2 + y^2$ is called ----------

   a) Definite b) indefinite c) positive definite d) positive semi definite

3. The value of 'Ω(12) is ------------

   a)1 b) 3 c) 5 d) None of the above

4. Define Pythagorean triangle

5. Public-key cryptography is also known as -----------

   a) Asymmetric cryptography b) Symmetric cryptography

   c) Both A and B d) None of the above

Part B

1. State and Prove Euler's theorem
2. State and prove Gauss Lemma.
3. For every positive integer n, σ(n) = $\prod_{p^\alpha//n} (\frac{p^{\alpha+1}-1}{p-1})$
4. If u and v are relatively prime positive integers whose product uv is a perfect square, then u and v are both perfect square.

5. Write a short note on authentication.

Part C

1. State and prove Chinese Remainder Theorem

2. State and prove Gaussian resiprocity law _ ___ __

2. State and prove Mobius inversion formula.

3. The positive primitive solutions of $x^2 + y^2 = z^2$ with y even are x= $r^2 - s^2$, y= 2rs, z= $r^2 + s^2$, where r and s are arbitrary integers of opposite party with r > s >0 and (r,s) =1

4. Explain the Diffle-Hellman key exchange system.

Teaching Plan

Elective II: c) Fuzzy Sets and their Applications

Department : **Mathematics (SF)**
Class : **I M.Sc. Mathematics (SF)**
Title of the Course : **Elective II: c) Fuzzy Sets and their Applications**
Semester : **I**
Course Code : **MP231EC6**

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP231EC6	4	1			3	5	75	25	75	100

Learning Objectives

1. To study about Fuzzy sets and their relations, Fuzzy graphs, Fuzzy Relations.
2. To gain knowledge on Fuzzy logic and laws of Fuzzy compositions.

Course Outcomes

CO	Upon completion of this course, the students will be able to:	PSO addressed	Cognitive level
CO - 1	understand the definition of Fuzzy sets and its related concepts	PSO - 1	K1 (R), K2 (U)
CO - 2	define Fuzzy Graphs and can explain the concepts	PSO - 2	K3 (Ap)
CO - 3	explain the concepts in Fuzzy sets and its relations	PSO - 3	K3 (Ap)
CO - 4	discuss about Fuzzy logic	PSO - 5	K2 (U)
CO - 5	analyze the compositions of Fuzzy sets.	PSO - 4	K4 (An)

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

Unit	Module	Topics	Teaching Hours	Cognitive level	Pedagogy	Assessment/ Evaluation
I						
	1	Fundamental Notions: Introduction, Review of the notion of membership	2	K1 (R), K2 (U)	Introductory session, Lecture with illustration	Questioning, Recall steps, concept with examples
	2	The concept of a fuzzy subset, Dominance relations	3	K4 (An)	Flipped classroom	Group discussion
	3	Simple operations on fuzzy subsets, Set of fuzzy subsets for E and M finite	4	K3 (Ap)	Lecture with illustration, Peer tutoring	Slip Test
	4	Properties of the set of fuzzy subsets, Product and algebraic sum of two fuzzy subsets	3	K2 (U)	Lecture with illustration	Brainstorming
II						
	1	Fuzzy Graphs and Fuzzy Relations: Introduction, Fuzzy graphs, Fuzzy relations	3	K1 (R), K2 (U)	Lecture using videos	Evaluation through short test
	2	Composition of fuzzy relations, Fuzzy subsets induced by a mapping	3	K2 (U)	Blended learning	Quiz using Nearpod
	3	Conditioned fuzzy subsets, Properties of fuzzy binary relations	3	K3 (An)	Context based	Slip Test, Quiz using gooogle forms
	4	Transitive closure of a fuzzy binary relation,	3	K4 (Ap)	Reflective Thinking	Formative Assessment I, Brainstorming

		Paths in a finite fuzzy graph				
III						
	1	Fuzzy preorder relations, Similitude relations, Similitude subrelations in a fuzzy preorder	3	K2 (U)	Demonstrative	concept with examples, Questioning
	2	Antisymmetry, Fuzzy order relations	2	K2 (U)	Lecture Method	Evaluation through short test
	3	Antisymmetric relations without loops, Ordinal relations, Ordinal functions in a fuzzy order relation, Dissimilitude relations	3	K3 (Ap)	PPT	Group discussion
	4	Resemblance relations, Various properties of similitude and resemblance	2			
	5	Various properties of fuzzy perfect order relations, Ordinary membership functions	2	K2 (U)	Demonstrative	concept explanations
IV						
	1	Fuzzy Logic: Introduction, Characteristic function of a fuzzy subset, Fuzzy variables	3	K1 (R), K2 (U)	Introductory session	concept with examples, Assignment
	2	Polynomial forms, Analysis of a function of fuzzy variables, Method of Marinos	3	K2 (U)	Context based	concept explanations, Quiz using Slido
	3	Logical structure of a function of fuzzy variables, Composition of intervals	2	K4 (An)	Brainstorming	concept explanations, Evaluation through short test

	4	Fuzzy propositions and their functional representations, The theory of fuzzy subsets and the theory of probability	4	K3 (Ap)	Lecture Method	Group discussion
V						
	1	The Laws of Fuzzy Composition: Introduction, Review of the notion of a law of composition	3	K2 (U)	Lecture Method	concept with examples, Seminar
	2	Laws of fuzzy internal composition, Fuzzy groupoids	3	K2 (U)	Demonstrative	Slip Test
	3	Principal properties of fuzzy groupoids, Fuzzy monoids	3	K3 (Ap)	Demonstrative	Oral Test
	4	Fuzzy external composition, Operations on fuzzy numbers	3	K2 (U)	Lecture Method	Quiz using Mentimeter, Formative Assessment II

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

Activities (Em/ En/SD): Discuss the logical structure of a function of fuzzy variables.
Course Focussing on Cross Cutting Issues (Professional Ethics/ Human Values/Environment Sustainability/ Gender Equity): Nil

Activities related to Cross Cutting Issues: Nil

Assignment: Fuzzy Logic

Seminar Topic: Laws of Fuzzy Composition

Sample questions

Part A

1. Complete: The theory of ordinary sets is a particular case of the theory of __________.
a) fuzzy set b) fuzzy subset c) algebraic product d) algebraic sum
2. Define fuzzy graphs.
3. Define fuzzy preorder relations.
4. Explain the concept of fuzzy variables.
5. What is a fuzzy groupoid?

Part B

1. Analyze the properties of fuzzy subsets.
2. Prove that the transitive closure of any fuzzy binary relation is a transitive binary relation.
3. Prove that in a reducible fuzzy preorder relation, there exists at least one similitude class, and the similitude classes form among themselves a fuzzy order relation if one considers the concept of the strongest path from one class to another.
4. Discuss the logical structure of a function of fuzzy variables.
5. Explain the law of fuzzy internal composition.

Part C

1. Explain the algebraic product and sum of two fuzzy subsets and provide an example.
2. Explain the concept of conditioned fuzzy subsets and give an example.
3. Discuss the properties and characteristics of similitude relations in fuzzy preorders. Provide examples to illustrate these properties
4. Explore the relationship between the theory of fuzzy subsets and the theory of probability.
5. Discuss the principal properties concerning fuzzy groupoids.

II PG

Teaching Plan

Complex Analysis

Class : **II M.Sc Mathematics**

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

Semester : **III**

Name of the Course : **Complex Analysis**

Course code : **MP233CC1**

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP233CC1	6	-	-	-	5	6	90	25	75	100

Objectives:

1.To understand the fundamental concepts and theorems of complex analysis, including Cauchy's Integral Formula, Taylor's Theorem, and the Residue Theorem.

2.To develop proficiency in applying complex analysis techniques to solve problems involving harmonic functions, power series expansions, and entire functions.

Course Outcomes

CO	Upon completion of this course the students will be able to	PSO Addressed	Cognitive Level
CO - 1	demonstrate the ability to compute line integrals over rectifiable arcs and apply Cauchy's Theorem to evaluate integrals in various domains	PSO - 1	K2(U), K3 (Ap)

CO - 2	interpret and apply advanced concepts such as Jensen's Formula and Hadamard's Theorem to analyze the behavior of entire functions and infinite products.	PSO - 3	**K3(Ap), K4(An)**
CO - 3	apply the calculus of residues to evaluate definite integrals and utilize harmonic functions to solve boundary value problems using Poisson's Formula and Schwarz's Theorem.	PSO - 4	**K3(AP), K5(E)**
CO - 4	construct power series expansions using Weierstrass's Theorem and apply partial fractions and factorization techniques to manipulate complex functions	PSO - 3	**K3(Ap), K6(C)**
CO - 5	analyze the local properties of analytic functions, including removable singularities, zeros, poles, and the Maximum Principle.	PSO – 2, 4	**K4 (An)**

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

Unit	Module	Topics	Teaching Hours	Cognitive level	Pedagogy	Assessment/ Evaluation
I	**Complex Integration**					
	1	Line Integrals and Rectifiable Arcs	2	K2(U)	Introductory session	Recall basic definitions
	2	Line Integrals as Functions of Arcs	2	K3(Ap)	Lecture using Chalk and talk	Oral Test
	3	Cauchy's Theorem for a Rectangle and Cauchy's Theorem in a Disk	5	K4(An)	Interactive PPT	Class Test
	4	Cauchy's Integral Formula	5	K3(Ap)	Flipped classroom	SlipTest

	5	Higher Derivatives	4	K2(U)	Inquiry Based Teaching	Online Quiz
II	**Local Properties of Analytic Functions**					
	1	Removable Singularities , Taylor's Theorem ,Zeros and Poles	3	K2(U)	Lecture using Chalk and talk	Recall basic definitions
	2	The Local Mapping and the Maximum Principle	5	K3(Ap)	Lecture with Illustration	Evaluation through short test
	3	The General Form of Cauchy's Theorem	5	K4(An)	Flipped classroom	MCQ using Nearpod
	4	The General Statement of Cauchy's Theorem and Proof of Cauchy's Theorem. .	5	K4(An)	Inquiry Based Teaching	Online Quiz
III	**The Calculus of Residues**					
	1	The Residue Theorem	4	K3(Ap)	Lecture using videos	MCQ
	2	The Argument Principle	2	K2(U)	Flipped classroom	MCQ using Nearpod
	3	Evaluation of Definite Integrals	5	K5(E)	Blended learning	Solving problems
	4	Harmonic Functions- Definition and Basic Properties	5	K3(Ap)	Lecture with Illustration	Formative Assessment Test I
	5	The Mean-Value Property	2	K4(An)	Interactive PPT using Gamma AI	Oral Test
IV						
	1	Poisson's Formula	3	K3(Ap)	Lecturewith Illustration	Oral Test

	2	Schwarz's Theorem and the Reflection Principle	4	K3(Ap)	Computational learning	Class test
	3	Power Series Expansions-Weierstrass's Theorem	4	K4(An)	Blended Learning	Evaluation through online quiz
	4	The Taylor's Series	4	K4(An)	Flipped classroom	Recall steps
	5	The Laurent Series	3	K2(U)	Seminar	MCQ using Nearpod
V	**Partial Fractions and Factorization**					
	1	Partial Fractions and Infinite Products	5	K2(U)	Lecture using videos	Recall basic definitions
	2	Canonical Products	5	K3(Ap)	Context based learning	Evaluation through online Quiz
	3	Entire Functions-Jensen's Formula	4	K4(An)	Flipped Classroom	Formative Assessment II
	4	Hadamard's Theorem	4	K4(An)	Reflective thinking	Slip test

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

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

Assignment:
1. Calculation of residues and evaluation of definite integrals
2. Jensen's formula and Hadamard's Theorem

Seminar Topic: Schwarz's Theorem and the Reflection Principle, the Taylor's Series and the Laurent Series.

Sample questions:

Part-A

1. Define rectifiable arcs and provide an example.

2. Define removable singularities and give an example.

3. The poles and residues of the function $\frac{1}{z^2+5z+6}$ are---------

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

a) 0 b)-1 c)1 d) π

5. Define a Laurent series and give an example

Part – B

Answer all the questions

1.State and prove Cauchy's integral formula.

2.State and prove Lioville's theorem

3. State and prove Rouche's theorem.

4. State and prove Schwarz's theorem

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

Part – C

Answer all the questions

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

2. State and prove Residue theorem.

3. Evaluate $\int_0^\pi \frac{d\theta}{a+cos\theta}$, a >1

4. State and prove Weierstrass's theorem.

5. 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.

Teaching Plan

Class : **II M.Sc Mathematics**

Title of the course : **Major Core X Topology**

Semester : **III**

Name of the Course : **Topology**

Course code : **MP233CC2**

Course Code	L	T	P	Credits	Inst. Hours	Total Hours	Marks		
							CIA	External	Total
MP233CC2	6	-	-	5	6	90	25	75	100

Objectives

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

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

Course outcomes

CO	pletion of this course, the students will be able to:	PSO addressed	Cognitive level
CO - 1	recall the definitions of topological space, basis, various topologies, closed sets, limit points, continuity, connectedness, compactness, separation axioms and countability axioms and completeness	PSO - 3	K1
CO - 2	defends the basic results in topological spaces, continues functions, connectedness, compactness, countability and separation axioms and complete metric spaces	PSO - 4	K2
CO - 3	solve problems on topologicals spaces, continuous functions and topological properties.	PSO - 3	K3
CO - 4	analyse various facts related to continuous functions, connected spaces, compact spaces, countable spaces, separable spaces, normal space and compact spaces .	PSO - 2	K4
CO - 5	evaluate the comparision between different types of topological spaces	PSO - 1	K5

Unit	Module	Topic	Teaching Hours	Cognitive level	Pedagogy	Assessment/ Evaluation
I						
	1.	Definition of topology, discrete and indiscrete topology, finite complement topology, Basis for a topology and examples, Comparison of standard and lower limit topologies	3	K2(U)	Lecture with Illustration	Evaluation through test
	2.	Order topology: Definition & Examples, Product topology on XxY: Definition & Theorem	3	K1(R)	Lecture with Illustration	Recall concept definition and steps
	3.	The Subspace Topology: Definition & Examples, Theorems	3	K3(Ap)	Lecture with Examples	Concept explanations
	4.	Closed sets: Definition & Examples, Theorems, Limit points: Definition Examples & Theorems , Hausdorff Spaces: Definition & Theorems	5	K4(An)	Discussion with Illustration	True/ False
	5	Continuity of a function: Definition, Examples, Theorems, Homeomorphism: Definition & Examples, Rules for constructing continuous function, Pasting lemma & Examples, Maps into products	5	K2(U)	Lecture with Illustration	Evaluation through short test
II						

	1	The Product Topology: Definitions,Comparison	3	K6(C)	Lecture with PPT	Check knowledg

		of box and product topologies, Theorems related to product topologies, Continuous functions and examples				e in topologies
	2	The Metric Topology: Definitions and Examples, Theorems, Continuity of a function, The sequence lemma, Constructing continuous functions, Uniform limit theorem, Examples and Theorems	5	K3(A)	Lecture with illustration	Questioning
	3	Connected Spaces: Definitions, Examples, Lemmas and Theorems, Connected Sub space of the real lines: Definitions and Examples, Theorems, Intermediate value theorem, connected space open and closed sets, lemma, examples,Theorems.	5	K2(U)	Lecture using videos	Evaluation through Assessment Test
	4	Components and Local Connectedness: Definitions, Path components, Locally connected, Locally path connected: Definitions and Theorems	3	K3(A)	Group Discussion	Quiz(google forms)
III						

	1	Compact space: Definition, Examples, Lemma, Theorems and Image of a compact space, Product of finitely many compact spaces, Tube lemma, Finite intersection property: Definition & Theorem	4	K2(U)	Lecture with PPT Illustration	Evaluation through Quiz(nearpod)
	2	Compact Subspaces of the Real Line: Theorem, Characterize compact subspaces of R^n, Extreme value theorem, The Lebesgue number lemma, Uniform continuity theorem	3	K3(A)	Lecture with Illustration	concept explanations, Evaluation through test
	3	Limit Point Compactness: Definitions, Examples and Theorems, Sequentially compact	2	K6(C)	Lecture with examples	Check knowledg e through Assignme nt
	4	Local compactness: Definition & Examples, Theorems	3	K2(U)	Lecture with PPT Illustration	Evaluatio n through MCQ, Short test
IV						
	1	First Countability axiom, Second Countability axiom: Definitions, Theorems, Dense subset: Definitions & Theorem, Examples, Lindelof space: Definition , Examples	3	K2(U)	Lecture and group discussion	Evaluatio n through Quiz (Slido)

	2	The Separation Axioms: Regular space & Normal space: Definitions,Lemma,Relation between the separation axioms, Examples based on separation axioms, Theorem based on separation axioms and Metrizable space	4	K4(An)	Lecture with Illustration	Evaluation through Quiz (Slido)
	3	Normal Spaces: Theorems and Examples	2	K2(U)	Lecture with Illustration	Evaluation through Test
	4	Urysohn lemma	3	K3(A)	Lecture	Explain concept

						with examples
V						
	1	Urysohn Metrization theorem,Imbedding theorem	3	K4(An)	Lecture with PPT Illustration	Explain concept with examples
	2	Tietze extension theorem	3	K5(E)	Lecture with Illustration	Evaluatio n through Assessme nt test
	3	Complete Metric Spaces: Definitions, Examples and Theorems, Isometric embedding	3	K3(A)	Lecture with PPT Illustration	Evaluatio n through Slip test
	4	Compactness in Metric spaces: Totally bounded, Pointwise bounded, Equicontinuous, Definitions, Lemmas,Theorems	3	K3(A)	Lecture with PPT	Explain concept with examples

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Course Focussing on: Skill Development

Activities: Comparison of box and metric topology, group discussion ,seminar, List out real life application of metric topology.

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

Activities related to

Cross Cutting

Issues:Nil

Assignment:

Connected subspace

of the Real Line

Seminar Topic:

Countable Spaces

SAMPLE QUESTION

Part A

1. The indiscrete topology on X consist of . . . .

2. A set U is open in metric topology induced by d iff

   (i) For each $y \in U$, there is $\delta > 0$ such that $(y,) \subset U$

   (ii)For each $y \in U$, each $\delta > 0$ such that $(y,) \subset U$

   (iii)For some $y \in U$,there is$\delta > 0$ suchthat $B(y,\delta) \subset U$

   (iv)For some $y \in U$, each $\delta > 0$ such tha t$(y,\delta) \subset U$

3. Say true or false

   Every compact subspace of a Hausdorff space is closed.

4. Every regular space with a__________________is normal.

5. An arbitrary product of compact spaces is compact in the product topology is the statement of

   a.Tietze extension theorem b)Tychonoff theorem c) Imbedding theorem.

Part B

1.Let$A$ be a subset of the topological space X.Then prove that $x \in \bar{A}$ if and only if every Open set U containing intersects A.

2.If each space X_α is a Hausdorff space, then show that $\prod$ is a Hausdorff space in Both the box and product topologies.

3.State and prove uniform continuity theorem.

4.Show that every compact Hausdorff space is normal.

5.If $\subset X$ and f: $A \to Z$ is a continuous map of A into the Hausdorff space Z. Then prove that there is at most one extension of f to a continuous function$g$:$\bar{A} \to Z$.

Part C

1.If A is a subspace of X and B is subspace of Y,then prove that the product topology on $A \times B$ is same as the topology $A \times B$ inherits as a subspace of $X \times Y$.

2.State and prove the intermediate value theorem.

3.Let X be a metrizable space. Then prove that the following are equivalent:
(i) X is compact. (ii) X is limit point compact. (iii)X is sequentially compact

4.State and prove Urysohn Lemma.

5.State and prove Tietze extension theorem.

Teaching Plan

Traditional Mechanics

Department : Mathematics S.F
Class : II M. Sc Mathematics
Title of the Course : Core Course IX : Traditional Mechanics
Semester : III
Course Code : MP233CC3

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP233CC3	6	-	-	-	5	6	90	25	75	100

Objectives

1. To gain deep insight into concepts of Dynamics
2. To do significant contemporary research.

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Course Outcomes

On the successful completion of the course, students will be able to:		
1.	grasp concepts like time dilation, relativistic dynamics, and the equivalence principle.	**K1**
2.	understand classical mechanics principles such as coordinates, constraints, and energy-momentum relationships for analyzing mechanical systems.	**K2**
3.	apply Lagrangian methods to special cases such as impulsive motion and systems with constraints, thereby expanding their problem-solving abilities	**K3**
4.	integrate classical and relativistic mechanics, enabling them to analyze systems ranging from everyday mechanics to those involving high speeds and gravity.	**K4**
5.	become proficient in using Lagrangian mechanics to solve complex problems and identify integral properties of motion.	**K5**

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

Unit	Module	Topic	Teaching Hours	Cognitive level	Pedagogy	Assessment/ Evaluation
I						
	1.	**The Mechanical System** – Equations of Motion- Units - **Generalized coordinates** – Degrees of Freedom- Generalized coordinates- Configuration Space	4	K2(U)	Lecture with illustration, Lecture using ICT tools	Questioning
	2.	**Constraints** – Holonomic Constraints - NonHolonomic Constraints- Unilateral Constraints- Example	4	K4(An)	Lecture using videos	Quiz using Slido
	3.	**Virtual Work** – virtual displacement- Principle of Virtual work- D'Alembert's Principle- Generalized Force- Example	4	K4(An)	Lecture with illustration	Assignment
	4.	**Energy and Momentum**- Potential Energy- Work and Kinetic Energy- Conservation of Energy	3	K3 (Ap) K4(An)	Lecture, PPT	Class test
	5.	Equilibrium and Stability- Kinetic Energy of a System- Angular Momentum- Generalized	3	K3 (Ap) K4(An)	Lecture, Interactive PPT	Assignment

		Momentum- Example				
II						
	1.	**Derivation of Lagrange's Equations**- Kinetic Energy- Lagrange's Equations- Form of the equations of motion- Nonholomorphic Systems	6	K2(U) K4 (An)	Lecture with illustration, Group Discussion	Class test
	2.	**Examples**- Spherical Pendulum- Double Pendulum- Lagrange multipliers and constraint forces- Particle in whirling tube- Particle with moving support- Rheonomic constrained system	6	K3(A p), K4 (An)	Lecture using Chalk and talk, Problem solving	Proble m solving, Home work
	3.	**Integrals of the motion**- Ignorable coordinates- Example- the Kepler Problem- Routhian function- Conservative Systems- Natural Systems- Liouville's system- Examples	6	K2(U) K4 (An)	Lecture using Chalk and talk	Online Quiz
II I						
	1.	**Special Applications of Lagrange's Equations** – Rayleigh's Dissipation Function	4	K2(U) K3(A p)	Lecture using Chalk and talk, PPT	Class test

	2.	**Impulsive Motion** – Impulse and momentum - Lagrangian method - Ordinary constraints - Impulsive constraints	8	K3(Ap) K4 (An)	Lecture using Chalk and talk, Problem solving	Problem solving
	3.	Energy considerations - Quasi – coordinates. Examples	6	K3(Ap)	Lecture using Chalk and talk, Problem solving	Home work
IV						
	1.	**Introduction to Relativity** – Introduction – Galilean transformation – Maxwell's equations – The ether theory – The principle of relativity	5	K2(U)	Lecture with illustration	Class test
	2.	**Relativistic Kinematics** – The Lorentz transformation equations – Events and simultaneity – Example- Einstein's train	4	K3(Ap)	Lecture using Chalk and talk, Peer teaching	Problem solving
	3.	Time dilation- Longitudinal contraction- the invariant interval –	4	K2(U) K4(An)	Lecture, Group Discussion	Assignment

		proper time and proper distance				
	4.	The world line –Example- the twin paradox - Addition of velocities – the relativistic Doppler effect	5	K3(Ap) K4(An)	Lecture using Chalk and talk, Peer tutoring	Slip test, Assignment
V						
	1.	**Relativistic Dynamics** - Momentum – Energy - The momentum-energy four vector	3	K2(U)	Lecture using Chalk and talk, Peer tutoring	Class test
	2.	Force – Conservation of energy – Mass and energy – inelastic collision	5	K2(U)	Lecture using Chalk and talk, Peer tutoring	Home work
	3.	The principle of equivalence - Lagrangian and Hamiltonian formulations	5	K4(An)	Lecture using Chalk and talk, Peer tutoring	Slip test, Assignments
	4.	Accelerated systems – Rocket with constant acceleration - Rocket with constant thrust	5	K3(Ap)	Graphical representation, Demonstration	Problem solving

Course Focussing on : Skill Development

Activities:, Assignment , Seminar, Online Quiz, Quiz Competition, Class Test, Group Discussion

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

Activities related to Cross Cutting Issues: Nil

Assignment: Solving problems using Lagrange's Equations, Solving Problems on Relativistic Dynamics

Seminar Topic: Special Applications of Lagrange's Equations - Examples, Relativistic Kinematics - Examples, Relativistic Dynamics - Examples

Sample questions:

Part A

1.Say true or false: The necessary and sufficient condition for static equilibrium is that all the Q's due to the applied forces be zero

2. Which principle is used in the derivation of Lagrange's equations?

A) Principle of least action B) Principle of virtual work C) Principle of superposition

D) Principle of conservation of energy

3**.** What is impulsive motion?

A) Motion under a constant force B) Motion due to a sudden force over a short time

C) Motion under zero force D) Motion with constant velocity

4. The principle of relativity states that the laws of physics are invariant in which frames of reference?

A) Rotating frames B) Accelerating frames C) Inertial frames D) Non-inertial frames

5. A rocket with constant acceleration in special relativity will experience which effect over time?

A) Increasing velocity without bound B) Constant velocity C) Decreasing velocity D) Infinite mass increase

Part B

1. Explain about degrees of freedom with illustration.
2. Eliminate ignorable co-ordinates from the equation of motion using Routhian function.
3. Explain about Rayleigh's Dissipation function.
4. Explain Maxwell's equations
5. Explain about the momentum-energy four vector

Part C

1. Explain D'Alembert's Principle.
2. Explain about the Liouville's system
3. Explain about Quasi Co-ordinates.
4. Explain about the relativistic Doppler effect.
5. Explain about accelerated systems and rocket with constant acceleration.

Teaching Plan

Department : Mathematics (SF)
Class : II M.Sc. Mathematics (SF)
Title of the Course : Elective V: c) Coding Theory
Semester : III
Course Code : MP233EC3

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP233EC3	4	-	-	-	3	4	60	25	75	100

Learning Objectives:

1. To learn the different procedures of coding and decoding.
2. To avail job opportunities in a number of detective agencies.

Course Outcomes

CO	Upon completion of this course, the students will be able to:	PSO addressed	Cognitive level
CO -1	gain a deep understanding of fundamental concepts in coding theory, and their applications in error detection and correction.	PSO - 1	K1 (R), K2 (U)
CO - 2	understand how the information theory principles influence the design and optimization of error-correcting codes.	PSO - 2	K2 (U)
CO - 3	apply combinatorial theory principles to construct efficient error-correcting codes, such as Hamming codes and Golay codes	PSO - 3	K3 (Ap)
CO - 4	explore advanced coding methods and understand their constructions, properties, and applications in modern communication systems and cryptography.	PSO - 2	K4 (An)
CO - 5	develop the ability to analyze and evaluate various coding techniques and algorithms, including majority logic decoding and weight enumerators	PSO - 4	K5 (E)

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

Unit	Module	Topics	Teaching Hours	Cognitive level	Pedagogy	Assessment/ Evaluation
I						
	1	**Mathematical Background:** Algebra – Definition of ideal, primitive element and trace, Theorems on rings and finite fields, trace.	3	K1 (R) K2 (U)	Introductory session, Lecture with illustration	Questioning, Recall steps, concept with examples
	2	Krawtchouk Polynomials – Definition of Krawtchouk polynomial, Krawtchouk expansion	2	K2 (U)	Flipped classroom	Concept definition, Group discussion
	3	Combinatorial theory – Definition of block design, Hadamard matrix, conference matrix, Theorem on Paley matrix	3	K2 (U) K3 (Ap)	Lecture with illustration, Peer tutoring	Slip Test
	4	Probability Theory – Chebyshev's Inequality, Stirling's Formula, Definition of binary entropy function	2	K3 (Ap) K4 (An)	Lecture Method	concept explanations, Quiz using Kahoot
II						

	1	**Linear codes:** Block codes – Definition of distance, weight, covering radius, perfect code	2	K2 (U)	Lecture using videos	concept definitions
	2	Linear codes – Definition of generator matrix, dual code, extended code, Theorem on minimum distance, minimum weight	2	K2 (U) K4 (An)	Flipped classroom	concept definitions, concept explanations
	3	Hamming codes – Definition of Hamming code, Theorem on Hamming code	2	K2 (U) K3 (Ap)	Blended learning	concept with examples, Quiz using Nearpod
	4	Majority logic decoding – Definition of orthogonal with respect to position	2	K2 (U)	Context based	concept definitions, Slip Test
	5	Weight Enumerators – Definition of weight enumerator, Theorem on weight enumerator, problems of linear codes	2	K3 (Ap) K5 (E)	Reflective Thinking	Oral Test, Brainstorming
III						
	1	**Some good codes:** Hadamard codes and generalizations	2	K2 (U)	Demonstrative	concept explanations, Questioning
	2	The binary Golay code – Theorems on binary code	3	K3 (Ap)	Lecture Method	Evaluation through short test
	3	The ternary Golay code	2	K3 (Ap)	PPT	concept explanations, Group discussion
	4	Constructing codes from other codes, Problems of codes	3	K5 (E)	Problem solving	concept explanations

IV						
	1	**Goppa Codes :** Motivation	2	K1 (R) K2 (U)	Introductory session	concept explanations
	2	Goppa Codes – Definition of Goppa code, Theorem on Goppa code	2	K2 (U) K3 (Ap)	Context based	concept explanations, Quiz using Slido
	3	The minimum Distance of Goppa Codes – Theorem	2	K4 (An)	Brainstorming	concept explanations, Evaluation through short test
	4	Asymptotic Behaviour of Goppa Codes – Theorem on Goppa codes	2	K3 (Ap)	Brainstorming	Slip Test
	5	Decoding Goppa Codes, Problems of Goppa codes	2	K5 (E)	Problem solving	Assignment
V						
	1	**Algebraic Geometry Codes:** Divisors – Definition of divisor, Theorems on divisor	3	K2 (U)	Context based	concept explanations, concept with examples, Seminar
	2	The Riemann -Roch Theorem - Theorems on divisor	3	K2 (U) K3 (Ap)	Demonstrative	Slip Test, Seminar
	3	Codes from Algebraic Curves – Definition of geometric generalized RS codes, Theorems on codes	4	K3 (Ap) K4 (An)	Lecture Method	concept explanations, concept with examples, Quiz using Mentimeter

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

Activities (Em/ En/SD): Solve problems of Golay codes

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

Activities related to Cross Cutting Issues: Nil

Assignment: Goppa codes

Seminar Topic: Algebraic Geometry Codes

Sample questions

Part A

1. Define Hadamard matrix.
2. What is a generator matrix?
3. Hadamard codes can be generated from which type of matrix?
   (a)Paley matrix (b) incidence matrix
   (c) generator matrix (d) Hadamard matrix
4. Say True or False: Goppa codes are linear.
5. What is a principal divisor?

Part B

1. Let m=2.3l-1. Then prove that xm+xm2+1 is irreducible over F2.
2. Prove that Hamming codes are perfect codes.
3. Explain the structure and properties of the Ternary Golay code.
4. Prove that the Goppa code (L, g) has dimension ≥n-mt and minimum distance ≥t+1.5.
5. Prove that D=l(W-D).

Part C

1. Let F be a field with n elements. Then prove that n is a power of a prime.
2. Let C be an [n, k] code over Fq with weight enumerator A(z) and let B(z) be the weight enumerator of C. Then prove that
   Bz= q-k1+(q-1)znA1-z1+(q-1)z.
3. Explain the structure and properties of the binary Golay code.
4. Prove that there exists a sequence of Goppa codes over Fq which meets the Gilbert bound.
5. Prove that the codes C(D, G) and C*(D, G) are dual codes.

SKILL ENHANCEMENT COURSE II- RESEARCH METHODOLOGY

Department : **Mathematics**

Class : **II M.Sc. Mathematics**

Title of the Course : **Skill Enhancement II: Research Methodology**

Semester : **III**

Course Code : **MP233SE1**

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP233SE1	3	-	-	-	2	3	45	25	75	100

Learning Objectives

1. To write a scientific research manuscript containing important key sections
2. To realize the importance of Research Ethics and methodologies involved in the research process

Course Outcomes

On the successful completion of the course, students will be able to:		
1	understand the objectives and methods of research , standard structure of a scientific paper and avoid plagiarism.	**K2**
2	analyzing research data and statistical measures such as measures of central tendency, dispersion, and asymmetry.	**K4**
3	identify the ethics of scientific paper writing and analyze research problems	**K4**
4	develop research designs for specific research problems and assess the significance of research in various fields.	**K5**
5	create structured scientific research papers and write project proposals and progress reports for research funding.	**K6**

K2 - Understand; **K3** - Apply; **K4** - Analyze; **K5**– Evaluate; **K6-** Create

Total contact hours: 45 (Including instruction hours, assignments and tests)

Unit	Module	Topic	Teaching Hours	Cognitive level	Pedagogy	Assessment/ Evaluation
I						
	1.	An Introduction to Research Methodology , Meaning of Research and Objectives of Research.	2	K2	Lecture with illustration	Q & A
	2.	Motivation in Research ,Types of Research, Research Approaches and Significance of Research	2	K2	Flipped Classroom	Short test
	3.	Research Methods versus Methodology, Research and Scientific Method , Importance of Knowing How Research is Done and Research Process.	3	K4	PPT using Gamma AI	Slip test
	4.	Criteria of Good Research and Problems Encountered by Researchers in India.	2	K2	Flipped Classroom	Online Quiz
II						
	1.	Defining the Research Problem, Selecting the Problem and Necessity of Defining the Problem	2	K4	Lecture using PPT	Q &A

	2.	Technique Involved in Defining a Problem , An Illustration , Research Design, Meaning of Research Design Need for Research Design and Research Methodology	3	K5	Blended classroom	Slip test
	3.	Features of a Good Design, Important Concepts Relating to Research Design and Different Research	2	K5	Lecture and Discussion	Quiz using nearpod
	4.	Designs , Basic Principles of Experimental Designs and Developing a Research Plan	2	K4	Lecture using Video	MCQ using Slido
III						
	1.	Processing and Analysis of Data **,** Processing Operations and Some Problems in Processing	3	K2	Lecture with illustratio n	Questioning
	2.	Elements/Types of Analysis , Statistics in Research and Measures of Central Tendency	3	K4	Lecture with PPT	Slip test
	3.	Measures of Dispersion and Measures of Asymmetry (Skewness)	3	K5	Lecture with illustratio n	Formative Assessment I
IV						
	1.	Research Project, Difference between a Dissertation and a Thesis and Basic Requirements of a Research Degree	2	K4	Lecture with PPT	Quiz using Slido
	2.	Deciding on a research topic , Writing a proposal , Familiarity with Codes of Practice/ Rules	3	K5	Lecture with illustration	Short test

		and Regulations, Ethical considerations				
	3.	Different components of a Research Project ,Title page, Abstract and Acknowledgement	2	K6	Blended classroom	Questioning
	4.	Introduction to List of Contents , Literature Review, Methodology and Style of Presentation	2	K5	Lecture with illustration	Short test
V						
	1.	Publishing and Presenting your Research and Tool kit	2	K5	PPT using Gamma AI	Q & A
	2.	Journal Articles –A book	2	K6	Seminar presentation	Short test
	3.	Conference Presentation	3	K5	Interactive PPT	Questioning
	4.	A final note and All punctuations	2	K6	Seminar presentation	Slip test

Course Focusing 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: Research and Scientific Method, Difference between a Dissertation and a Thesis and Basic Requirements of a Research Degree

Seminar Topic: Different components of a Research Project ,Title page, Abstract and Acknowledgement, Publishing and Presenting your Research and Tool kit.

Sample Questions:

Part A

1. Define research methodology.
2. Define research design
3. What is data processing in research?
4. Why is familiarity with codes of practice important in research?
5. Why is it important to present your research at a conference?

Part B

1. Describe the objectives of research
2. Describe a technique involved in defining a research problem.
3. Describe the different types of data analysis
4. Describe the importance of adhering to codes of practice and rules in research
5. Discuss the tools and techniques used for effective research presentations

Part C

1. Elaborate on the various types of research. Compare and contrast them with relevant examples
2. Discuss in detail the meaning and importance of research design. Explain how it contributes to the validity and reliability of a research study.
3. Define data processing in research and discuss the various processing operations. Explain the significance of each step in ensuring accurate data analysis
4. Analyze the process of deciding on a research topic. Explain the factors that should be considered to ensure the topic is relevant, feasible, and valuable
5. Discuss the process of publishing a research journal article. Explain the steps involved from manuscript preparation to acceptance and publication