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

TEACHING PLAN (PG)

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)

PEOs	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**
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 eco friendly 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**

PROGRAMMESPECIFICOUTCOMES(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**

PG-FIRST YEAR – SEMESTER – I

CORE – I: ALGEBRAIC STRUCTURES

Teaching Plan

Department : Mathematics

Class : I M.Sc
Title of the Course : ALGEBRAIC STRUCTURES
Semester : I
Course Code : MP231CC1

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

Learning Objectives

1. To understand the simple concepts of the theory of equations
2. To find the roots of the equations by using techniques in various methods.

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
CO-2	define Solvable groups, define direct products, examine the properties of finite abelian groups, define modules	PSO – 2	K2
CO-3	find similar Transformations, define invariant subspace, explore the properties of triangular matrix, to find the index of nilpotence to decompose a space into invariant	PSO - 2	K3

	subspaces, to find invariants of linear transformation, to explore the properties of nilpotent transformation relating nilpotence with invariants.		
CO-4	apply Jordan, canonical form, Jordan blocks, define rational canonical form in companion matrix of polynomial, find the elementary devices of transformation, apply the concepts to find characteristic polynomial of linear transformation.	PSO - 3	K4
CO-5	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 verify whether the transformation in Hermitian, unitary and normal	PSO - 3	K5

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

Unit	**Module**	**Topic**	**Teaching Hours**	**Cognitive level**	**Pedagogy**	**Assessment/ Evaluation**
I	**Unit-I**					
	1.	Counting Principle	3	K1 & K2	Brainstorming	MCQ
	2.	Class equation for finite groups	3	K2	Lecture with illustrations	Slip Test
	3.	Class equation for finite groups and ts applications	3	K3	Problem Solving	Questioning
	4.	Sylow's theorems	6	K4	Lecture Discussion	Questioning
II	**Unit-II**					
	1.	Solvable groups	4	K1 & K2	Brainstorming	True/False
	2.	Direct products	4	K2	Flipped Classroom	Short summary

	3.	Finite abelian groups	4	K2& K4	Lecture Discussion	Concept definitions
	4.	Modules	3	K3	Problem Solving	Quiz
III	**Unit-III**					
	1.	Linear Transformations:	3	K1 & K2	Brainstorming	Quiz
	2.	Canonical form	4	K2	Lecture with illustration	Explain
	3.	Triangular form	4	K2	Lecture Discussion	Slip Test
	4.	Nilpotent transformations	4	K3	Problem Solving	Open book Test
IV	**Unit-IV**					
	1.	Jordan form	3	K1 & K2	Brainstorming	Simple Questions
	2.	Differential equation of first order but of higher degree	4	K2	Blended Learning	Quiz
	3.	Equations solvable for p, x, y	4	K3	Integrative method	Explain the concept
	4.	rational canonical form	4	K1 & K2	Collaborative learning	Slip Test
V	**Unit -V**					
	1.	Trace and transpose - Hermitian, unitary, normal transformations, real quadratic form.	4	K1 & K2	Flipped Classroom	MCQ
	2.	Hermitian transformation	4	K2	Lecture with illustration	Concept explanations

	3.	unitary, normal transformations	4	K2 & K3	Problem Solving	Questioning
	4.	real quadratic form.	3	K2	Group Discussion	Recall steps

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

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

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

Activities related to Cross Cutting Issues: -

Assignment: **Unsolved Problems (From Reference books)**

Part A

1. Sylow p-subgroup of a group G is-------------
2. Define Internal Direct Product
3. If is finite dimensional over then the rank of is the dimension of-------------

   i. V b) T c) VT d) VT^{-1}

4 .The matrix is said to be a skew-symmetric matrix if----------------

a) $A' = A$ b) $A' = -A$ c) $A' = 0$ d) $A' = 1$

5. The only irreducible, non constant, polynomials over the field of real numbers are either of degree --.

a) 1 or 2 b) 0 or 2 c) 0 or 1 d) 1 or 3

Part B

1. Let G be a finite group. Prove that $C_a = o(G)/o(N(a))$.
2. Define double coset of 2 sub groups A and B in a group G and prove that

$$O(AxB) = \frac{O(A)O(B)}{O(A \cap xBx^{-1})}.$$

3. If V is finite dimensional over F then show that $T \in A(V)$ is invertible iff the constant

term of the minimal polynomial for is not 0.

4. State and prove the Jacobson lemma

5. Prove that det A = det(A').

Part C

1. Prove that $I(G) \cong G/Z$, where $I(G)$ is the group of inner automorphisms of G and Z is the centre of G.
2. State and prove Sylow's theorem.
3. If A is an algebra, with unit element over F, then prove that A is isomorphic to a subalgebraof $A(V)$ for some vector space V over F.
4. Prove that the elements S and T in ( ) are similar in ( ) if and only if they have the same elementary divisors.
5. Prove that the Hermitian linear transformation is non negative iff its characteristic rootsare nonnegative.

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Head of the Department	Course Instructor
Dr. T. Sheeba Helen	Dr.L.Jesmalar

Teaching Plan

Department : **Mathematics**

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

Title of the Course : Core 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	-	4	7	105	25	75	100

Learning Objectives

1. To work comfortably with functions of bounded variation, Riemann- Stieltjes Integration, convergence of infinite series, infinite product and uniform convergence.
2. 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: 105 (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	Recall the basic definitions	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	Summarize the concepts
	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	3	K2, K5	Illustrative Method	Questioning
	4.	Total variation on [a,x] as a function of the right end point x, Functions of	4	K2, K5	Lecture	Question and answer

		bounded variation expressed as the difference of increasing functions – Characterisation of functions of bounded variation, Continuous 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	3	K1	Brainstorming PPT	Questioning
	2.	Linear properties of Riemann - Stieltjes integral, Integration by parts, Connection between integrand and the integrator	3	K2	Discussion and Lecture	Slip test

		in a Riemann – Stieltjes integral				
	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	Q & A
	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 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	4	K2	Lecture	Quiz method
	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	3	K2	Lecture	Short test

		conditions for existence of Riemann – Stieltjes integrals				
	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	Problem-solving
	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	3	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	Intertactive 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	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	True/ False
	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,	3	K2	Introductory Session	Explain

		Examples of sequences of real valued functions				
	2.	Uniform convergence and continuity, Cauchy condition for uniform convergence	4	K2, K4	Lecture with illustration	Concept explanations
	3.	Uniform convergence of infinite series of functions, Riemann – Stieltjes integration, non-uniform convergence and term-by-term integration	2	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 Employability/ Entrepreneurship/ Skill Development: **Skill Development**

Activities (Em/ En/SD): **Problem-solving, Seminar Presentation, Group Discussion**

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

Activities related to Cross Cutting Issues: -

Assignment: **Solving Exercise Problems**

Seminar Topic: **Uniform convergence, Absolute and Conditional convergence, Dirichlet's test and Abel's test, Riemann's theorem on conditional convergent series, Sequences of Functions, Uniform convergence.**

Sample questions

Part A

1. Rectifiable arcs have ________ arc length

(a) infinite (b) finite (c) countably finite (d) countably infinite

2. If $a < b$, we define $\int_a^b f d\alpha =$ ________ whenever $\int_a^b f d\alpha$ exists.

3. State the first mean value theorem for Riemann Stieltjes Integral.

4. State True or False: The two series $\sum_{n=0}^{\infty} z^n$ and $\sum_{n=1}^{\infty} {z^n}/{n^2}$ have the same radius of convergence.

5. Differentiate between pointwise convergence and uniform convergence.

Part B

1. Assume that f and g are each of bounded variation on $[a, b]$. Prove that so are their sum, difference and product. Also, prove $V_{f\pm g} \leq V_f + V_g$ and $V_{f*g} \leq AV_f + BV_g$ where $A = sup\{|g(x)| : x \in [a, b]\}$, $B = sup\{|f(x)| : x \in [a, b]\}$.

2. Assume that $\alpha \nearrow$ on $[a, b]$. Then prove that $\underline{I}(f, \alpha) \leq \bar{I}(f, \alpha)$.

3. Assume $f \in R(\alpha)$ and $g \in R(\alpha)$ on $[a, b]$, where $\alpha \nearrow$ on $[a, b]$. Define $F(x) = \int_a^x f(t) d\alpha\,(t)$ and $G(x) = \int_a^x f(t) d\alpha\,(t)$ if $x \in [a, b]$. Then prove that $f \in R(G)$ and $g \in R(F)$ on $[a, b]$ and we have $\int_a^b f(x)g(x) d\alpha\,(x) = \int_a^x f(x) dG\,(x) = \int_a^x g(x) dF\,(x)$.

4. Assume that the power series $\sum_{n=0}^{\infty} a_n(z - z_0)^n$ converges for each z in $B(z_0; r)$. Then prove that the function f defined by the equation $f(z) = \sum_{n=0}^{\infty} a_n(z - z_0)^n$, if $z \in B(z_0; r)$, is continuous on $B(z_0; r)$.

5. Let $\{f_n\}$ be a sequence of functions defined on a set S. There exists a function f such that $f_n \to f$ uniformly on S if, and only if, the Cauchy condition is satisfied: For every $\epsilon > 0$ there exists an N such that $m > N$ and $n > N$ implies $|f_m(x) - f_n(x)| < \varepsilon$, for every x in S.

Part C

1. State and prove the additive property of total variation.

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

3. State and prove the second fundamental theorem of integral calculus.

4. State and prove Abel's limit theorem.

5. State and prove Weierstrass M-test.

Head of the Department   Course Instructor

Dr. T. Sheeba Helen   S. Antin Mary

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
MP241CC3	5	1	-	4	6	90	25	75	100

Learning Objectives

1. To develop strong background on finding solutions to linear differential equations with constant and variable coefficients and also with singular points.
2. To study existence and uniqueness of the solutions of first order differential equations

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	PSO-4	**K3**

	differential equations, distinguishing between ordinary points and regular singular points.		
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	K6	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	The Existence and Uniqueness of solutions					
	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**

Assignment: Exercise Problems in The Gamma functions

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 $y'' + P(x)y' + Q(x)y = 0$ 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 isthe 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 $\Gamma(1)$ 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 ofa 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 $\frac{dx}{dt} = x + y$ & $\frac{dy}{dt} = 4x - 2y$
16. Solve the system of equations $\frac{dx}{dt} = 2x$ & $\frac{dy}{dt} = 3y$
17. Prove that $P_n(1) = 1$, $P_n(-1) = (-1)^n$.

18. Find the first three terms of the Legendre's series of $f(x) = e^x$

19. Derive Picard's iteration formula for the initial value problem $y' = f(x, y)$, $y(x_0) = y_0$ 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 $y' = 2x(1 + y)$, $y(0) = 1$

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 obtainthe 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 $\frac{dx}{dt} = 5x + 4y$ & $\frac{dy}{dt} = -x + y$

26. Find the solution of the homogeneous system $\frac{dx}{dt} = 4x - 2y$ & $\frac{dy}{dt} = 5x + 2y$

27. Prove that $\Gamma\left(\frac{1}{2}\right) = \sqrt{\pi}$

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 $|f(x,y_1) - f(x,y_2| \leq K|y_1 - y_2|$ on the strip by $a \leq x \leq b$ and $-\infty < y < \infty$. If $f(x_0,y_0)$ is any point on the strip then prove that the initial value problem $y' = f(x,y), y(x_0) = y_0$ has one and only solution y=y(x) on the interval $a \leq x \leq b$.

Head of the Department | Course Instructor

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

TEACHING PLAN

Department: Mathematics

Class: I M.Sc

Title of the Course: Elective Course 2: Graph Theory and Applications

Semester: I

Course Code: MP231EC2

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP231EC2	5	-	-		3	5	75	25	75	100

Objectives:

1. To help the students to understand various parameters of Graph Theory with applications.
2. To stimulate the analytical mind of the students, enable them to acquire sufficient knowledge and skill in the subject that will make them competent in various areas of mathematics.

Course Outcomes

On the successful completion of the course, student will be able to:		
CO - 1	recall the basic concepts of graph theory and know its various parameters	**K1**
CO - 2	explain the results derived on the basis of known parameters	**K2**
CO - 3	apply the concepts to evaluate parameters for the family of graphs	**K3 & K5**
CO - 4	analyze the steps of various theorems and know its applications	**K1 &K4**
CO - 5	create a graphical model for the real-world problem using the relevant ideas	**K6**

K1-Remember **K2**- Understand K**3** - Apply **K4**- Analyze K**5**–Evaluate **K6** - Create

Teaching Plan

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

Unit	Module	Topic	Teaching Hours	Cognitive level	Pedagogy	Assessment/ Evaluation
I						
	1.	Trees - Cut Edges and Bonds, Cut Vertices.	6	K1(R)	Lecture with illustration	Simple questions
	2.	Connectivity, Blocks	5	K4 (An)	Inductive learning	Concept explanations
	3.	Construction of Reliable Communication Networks	4	K3(Ap)	Heuristic method	Quiz
II						
	1.	Euler Tours	5	K2(U)	Lecture with PPT	Class test, Home work
	2	Hamilton Cycles	5	K2(U)	Lecture with illustration	Assignments
	3	The Chinese Postman Problem, Fleury's Algorithm	5	K2(U), K3(Ap)	Analytic Method	Formative Assessment
III						
	1.	Matchings	5	K1(R)	Interactive method	Brain Storming
	2.	Edge Colourings- Edge Chromatic Number	5	K4 (An)	Lecture with illustration	MCQ
	3.	Vizing's Theorem	5	K3(Ap)	Flipped claassroom	Concept explanations

IV						
	1.	Independence sets and Cliques -Independent Sets	5	K2(U)	Participative Learning	Problem solving questions, Home work

	2.	Vertex Colourings - Chromatic Number	5	K4 (An)	Group Discussion, Problem solving	Evaluation through solving exercise problem
	3.	Brook's Theorem, Hajos' Conjecture	5	K2(U)	Blended learning	Slip test
V						
	1.	Planar Graphs- Plane and Planar Graphs	5	K4 (An)	Lecture with illustration	PPT Presentation
	2.	Euler's Formula, Kuratowski's Theorem (statement only)	5	K3(Ap)	Synthetic method	Slip Test
	3.	The Five Colour Theorem and Four Colour Conjecture	5	K2(U)	Blended learning	Formative Assessment

Course Focusing on Employability/Entrepreneurship/Skill Development: Employability

Activities (Em/En/SD): Evaluation through Short tests, Quizzes and Seminars

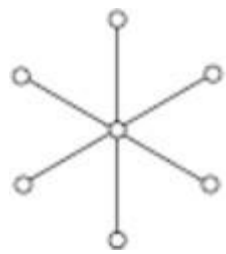
Assignment: Hamilton Cycles

Seminar Topic: Planar Graphs

Sample Questions:

Part -A

1. Define Hamilton path of a graph
2. A cut edge of G is an edge such that ---------
3. A simple graph is Hamiltonian iff -----------
4. What is the chromatic number of the tree?



a) 3 b) 5 c) 7 d) 2

Part – B

5. An edge e of G is a cut edge of G iff e is contained in no cycle of G.
6. In a critical graph, no vertex cut is a clique.
7. Every planar graph is 5 – vertex colourable.

Part – C

8. Let T be a spanning tree of a connected graph G and let e be an edge of G not in T. Then T+e contains a unique cycle.
9. A non empty connected graph is Eulerian iff it has no vertices of odd degree.
10. A matching M in G is a maimum matching iff G contains no M- augmenting path.

Head of the Department	**Course Instructor**
Dr. T. Sheeba Helen	Dr. J. Befija Minnie

Department : **Mathematics**
Class : **I M.Sc Mathematics**
Title of the Course : **ELECTIVE COURSE II: b) ANALYTIC NUMBER THEORY**

Semester : **I**
Course Code : **MP231EC5**

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP231EC5	4	1	-	-	3	5	75	25	75	100

Prerequisites: Knowledge of differential and integral calculus of real functions in several variables, convergence of series, (uniform)convergence of sequences of functions, basics of complex analysis

Learning Objectives

1. To understand Dirichlet multiplication, a concept which helps clarify Interrelationship between various arithmetical functions.
2. To understand some equivalent forms of the prime number theorem.

Course Outcomes

Upon completion of this course, the students will be able to:		
CO1	study the basic concepts of elementary number theory	**K1, K2**
CO2	explain several arithmetical functions and construct their relationships	**K3**
CO3	apply algebraic structure in arithmetical functions	**K3**
CO4	demonstrate various identities satisfied by arithmetical functions	**K2**
CO5	determine the application to $\mu(n)$&$\Lambda(n)$ and several equivalent form of prime number theorem	**K4**

Teaching plan

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

Unit	Module	Topic	Teaching Hours	Cognitive level	Pedagogy	Assessment/ Evaluation
I	**The Fundamental Theorem of Arithmetic**					
	1.	Divisibility, Greatest Common Divisor	3	K2(U)	Lecture, Illustration	Evaluation through short test, MCQ, True/False, Short essays, Concept explanations
	2.	Prime Numbers	3	K1(R)	Lecture, Group discussion	Simple definitions, MCQ, Recall steps, Concept definitions
	3.	The Fundamental Theorem of Arithmetic	3	K2(U)	Lecture, Discussion	Suggest idea/concept with examples, Suggest formulae, Solve problems
	4.	The Series of reciprocals of the primes	3	K4(An)	Lecture, Illustration	Evaluation through short test, Seminar
	5.	The Euclidean algorithm, The GCD of more than Two Numbers	3	K3(Ap)	Peer tutoring, Lecture using videos, Problem solving	Evaluation through short test
II	**Arithmetic Functions**					
	1.	The Mobius function, The Euler totient function	3	K1(R)	Lecture using Chalk and talk ,Introductory session, Group Discussion, Mind mapping, Peer tutoring, Lecture using videos, Problem solving, Demonstration, PPT, Review	Simple definitions, MCQ, Recall steps, Concept definitions Suggest idea/concept with examples, Suggest formulae, Solve problems Evaluation through short test, Seminar
	2.	A relation connecting ϕ and μ, The product formula for ϕ	3	K2(U)		
	3.	The Dirichlet product of arithmetical functions	3	K3(Ap)		
	4.	Dirichlet inverses and the Mobius inversion formula	3	K2(U)		
	5.	The Mangoldt function	3	K4(An)		

III	**Multiplicative Functions and Dirichlet Multiplication**					
	1.	Multiplicative functions	3	K1(R)	Lecture, Illustration	Evaluation through short test, MCQ, True/False, Short essays, Concept explanations
	2.	Multiplicative functions and Dirichlet multiplication	3	K3(Ap)	Lecture, Group discussion	Simple definitions, MCQ, Recall steps, Concept definitions
	3.	The inverse of a completely multiplicative function	3	K3(Ap)	Lecture, Discussion	Suggest idea/concept with examples, Suggest formulae, Solve problems
	4.	Liouville's function	3	K4(An)	Lecture, Illustration	Evaluation through short test, Seminar
	5.	The divisor's function σ_x(n) , Generalized convolutions	3	K2(U)	Group Discussion, Mind mapping	Group Discussion, Mind mapping
IV	**Averages of Arithmetical Functions**					
	1.	Asymptotic equality of functions, Euler's summation formula	3	K2(U)	Lecture using Chalk and talk ,Introductory session, Group Discussion, Mind mapping,	Seminar on measure spaces, measurable functions and integration. Short test on general convergence theorems and signed measures
	2.	Some elementary asymptotic formulas	3	K1(R)		
	3.	The average order of d(n), The average order of the divisor functions σ_x(n)	3	K3(Ap)		
	4.	The average order of ϕ(n), An application to the distribution of lattice points visible from the origin	3	K4(An)		
	5.	The average order of μ(n) and $\wedge$(n)	3	K2(U)		
V	**Partial sums of Dirichlet Product**					
	1.	Partial sums of Dirichlet Product	3	K1(R)	Lecture, Group discussion	Seminar on outer measure, measurability

	2.	Applications of μ(n) and $\wedge$(n)	3	K3(Ap)		and extension theorem Short test on outer measure and measurability
	3.	Chebyshev's Functions	3	K4(An)		
	4.	Some equivalent forms of Prime Number Theorem	3	K2(U)		

Course Focussing on Skill Development

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

Assignment : **Partial sums of Dirichlet Product**

Seminar Topic: **Averages of Arithmetical Functions**

Sample questions

Part A

1. What is the value of (p, a), if a prime p does not divide a?

(a)1 (b)∞ (c)0 (d)-1

2. According to the Fundamental Theorem of Arithmetic, which of the following statements is true?

a) The prime factorization of a number is always unique, except for the order of the factors.

b) The prime factorization of a number is unique, including the order of the factors.

c) Some numbers cannot be expressed as a product of prime factors.

d) The prime factorization of a number includes at least one even prime.

3. Which of the following statements best describes the Fundamental Theorem of Arithmetic?

a) Every integer greater than 1 can be expressed as a sum of prime numbers.

b) Every integer greater than 1 can be expressed as a unique product of prime numbers, up to the order of the factors.

c) Every integer greater than 1 can be expressed as a unique difference of prime numbers.

d) Every integer greater than 1 can be expressed as a unique product of even numbers.

3. Which of the following functions is an example of a multiplicative arithmetic function?

a) ϕ(n) b) σ(n) c) μ(n) d) All of the above

4. What is the value of the Möbius function **μ(n)** for **n=30n**?

a) 0 b) 1 c) -1 d) 2

5. The sum of divisors function **σ(n)** is defined as the sum of all positive divisors of **n**. What is **σ(12)**?

a) 16 b) 24 c) 28 d) 30

Part B

1. Prove that every integer n>1 is either a prime number or a product of prime numbers.
2. State and prove Euclid's Lemma.
3. Define Mobius function and Mangoldt function.
4. State and prove Euler's summation formula.
5. State and prove Abel's Identity.

Part C

1. State and prove fundamental theorem of arithmetic
2. State and prove Selberg identity.
3. State and prove Legendre's identity.
4. Derive Dirichlet Asymptotic Formula.
5. **5.** (i) Prove that if f is multiplicative, then f is completely multiplicative iff $f^{-1}(n)=\mu(n)f(n)$.

   (ii) If f is multiplicative, then prove that $\sum_{d|n}\mu(d)f(d)=\prod_{p|n}(1-f(p))$.

Head of the Department

Dr. T. Sheeba Helen

Course Instructor

Dr. A. Jancy Vini

Teaching Plan

Department : Mathematics

Class : II M. Sc Mathematics

Title of the Course : Complex Analysis

Semester : III

Course Code : MP233CC1

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

Objectives

- To understand the fundamental concepts and theorems of complex analysis, including Cauchy's Integral Formula, Taylor's Theorem, and the Residue Theorem.
- 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, K3**
CO - 2	analyze the local properties of analytic functions, including removable singularities, zeros, poles, and the Maximum Principle.	PSO - 3	**K4**
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, K5**
CO - 4	construct power series expansions using Weierstrass's Theorem and apply partial fractions and factorization techniques to manipulate complex functions.	PSO - 3	**K3, K6**
CO - 5	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 – 2, 4	**K3, K4**

Teaching plan

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

Unit	Module	Topic	Teaching Hours	Cognitive level	Pedagogy	Assessment/ Evaluation
I	**Complex Integration and Cauchy's Integral Formula**					
	1.	Line Integrals	2	K2	Brainstorming	Questioning
	2.	Rectifiable Arcs	2	K2	Inductive Learning	Recall Steps
	3.	Line Integrals as Functions of Arcs	2	K2	Blended Learning	Slip Test
	4.	Cauchy's Theorem for a Rectangle	2	K2	Blended Learning	Proof Narrating
	5.	Cauchy's Theorem in a Disk	1	K2	Blended Learning	Proof Narrating
	6.	The index of a point with respect to a curve	3	K3	Flipped Classroom	Short Answer – Google Form
	7.	Cauchy's Integral formula	2	K3	Heuristic Method	MCQ
	8.	Higher Derivatives	3	K3	Derivative Method	Recall Steps
II	**Local Properties of Analytic Functions and The General Form of Cauchy's Theorem**					
	9.	Removable Singularities, Taylor's Theorem	2	K3	PPT using Gamma	Relay Race
	10.	Zeros and Poles	2	K3	Brainstorming	Match the following – Gamma
	11.	The Local Mapping	2	K3	Brainstorming	Questioning
	12.	The Maximum Principle	2	K3	Interactive Method	Slip Test
	13.	Chains and Cycles	2	K2	PPT using Microsoft 365	True or False
	14.	Simple Connectivity	2	K2	Heuristic Method	Peer Discussion with questions
	15.	Homology, The General Statement of Cauchy's Theorem	2	K2	Blended Learning	Creating Quiz with Group Discussion

	16.	Proof of Cauchy's Theorem	2	K2	Interactive Method	Constructing Proof Ideas
III	**The Calculus of Residues and Harmonic Functions**					
	17.	The Residue Theorem	2	K5	Blended Learning	Relay Race
	18.	The Argument Principle	2	K3	Inductive Learning	Proof Writing
	19.	Evaluation of Definite Integrals	6	K5	Problem Solving	Solve Problem
	20.	Definition and Basic Properties of Harmonic Functions	3	K2	Brainstorming	Questioning
	21.	The Mean-Value Property	3	K3, K5	PPT using Microsoft 365	Slip Test
IV	**Harmonic Functions and Power Series Expansions**					
	22.	Poisson's Formula	2	K3	Flipped Classroom	Presentation
	23.	Schwarz's Theorem	2	K3	Flipped Classroom	Presentation
	24.	The Reflection Principle	2	K3	Flipped Classroom	Presentation
	25.	Weierstrass's Theorem	2	K3	Flipped Classroom	Presentation
	26.	The Taylor's Series	3	K5	PPT	Proof Narrating
	27.	The Laurent Series	3	K5	Video using Zoom	Quiz - Socrative
V	**Partial Fractions and Factorization and Entire Functions**					
	28.	Partial Fraction	3	K2	Video using Zoom	Quiz – Gamma
	29.	Infinite Products	2	K2	Video using Zoom	MCQ – Slido
	30.	Canonical Products	2	K2	Video using Zoom	Slip Test
	31.	Jensen's Formula	2	K2	Analytic Method	Proof Narrating
	32.	Hadamard's Theorem	3	K2	Heuristic Method	Proof Narrating

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

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

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

Activities related to Cross Cutting Issues: -

Assignment: Evaluation of Definite Integrals

Sample questions (minimum one question from each unit)

Part A

Unit I

1. The winding number of a point inside the circle is
   (i) 1 (ii) 0 (iii) ∞ (iv) None of these
2. The value of Cauchy's Estimate is …….

Unit II

1. If $f(z)$ is analytic and non-constant in a region Ω , then which value of $f(z)$ has no maximum in Ω?
2. The maximum value of modulus of $f(z)$ attains in ……………

Unit III

1. The value of $\int_0^\pi \log sinz\, dz$
   (i) $\pi \log 2$ (ii) $-\pi \log 2$ (iii) $\log 2$ (iv) $-\log 2$
2. If $f(z)$ is analytic in a region Ω, then $\int_\gamma f(z)dz = 0$ for every cycle γ which is homologous to zero in Ω. This statement is known as …………

Unit IV

1. True or False: Taylor's Series is valid in throughout the complex plane.
2. Discuss the convergence of the series $\sum_{n=0}^{\infty} b_n z^{-n}$.

Unit V

1. If $\lim_{n\to\infty} P_n = 0$, then the infinite product $\prod_{n=1}^{\infty} Pn$ is ………..
2. Write the two standard representation of rational function.

Part B

Unit I

1. If the piecewise differentiable closed curve γ does not pass through the point a, then the value of the integral $\int_{\gamma} \frac{dz}{z-a}$ is a multiple of $2\pi i$.
2. (i). If γ lies inside a circle, then $n(\gamma, a) = 0$ for all points a outside the circle
   (ii). If a is a point inside the circle C, then $n(\gamma, a) = 1$.

Unit II

1. State and prove Liouville's Theorem.
2. An analytic function comes arbitrary close to any complex value in every neighbourhood of an essential singularity.

Unit III

1. Evaluate $\int_{0}^{2\pi} \frac{1}{a+cos\theta} d\theta, a > 1$.
2. Evaluate $\int_{0}^{\infty} \frac{x^2-x+2}{x^4+10x^2+9} dx$.

Unit IV

1. Find Suppose that $u(z)$ is harmonic for $|z| < R$, continuous for $|z| \leq R$. Then show that $u(a) = \frac{1}{2\pi} \int_{|z|=R} \frac{R^2-|a|^2}{|z-a|^2} u(z) d\theta$.
2. Show that the function $P_U(z)$ is harmonic for $|z| < 1$ and $\lim_{z \to e^{i\theta_0}} P_U(z) = U(\theta_0)$ provided that U is continuous at θ_0.

Unit V

1. Find the expansion of $\pi \ cot\pi z$ by Mittag Leffler Theorem.
2. Show that $sin\pi z$ is an entire function of genus 1;

Part C

Unit I

1. State and prove Cauchy's Theorem for Rectangle.
2. Let $f(z)$ be analytic in an open disk Δ and γ be a closed curve in Δ. Then for any point a not on γ, $n(\gamma, a). f(a) = \frac{1}{2\pi i} \int_{\gamma} \frac{f(z)}{z-a} dz$, where $n(\gamma, a)$ is the index of a with respect to γ. Also derive the Cauchy's Integral Formula.

Unit II

1. A region Ω is simply connected if and only if $n(\gamma, a) = 0$ for all cycles γ in Ω and all points a which do not belong to Ω.

2. Let $f(z)$ be analytic except for isolated singularities a_j in a region Ω. Then $\frac{1}{2\pi i}\int_\gamma f(z)dz = \sum_j n(\gamma, a_j) Res_{z=a_j} f(z)$ for any cycle γ which is homologous to zero in Ω and does not pass through any one of the points a_j.

Unit III

1. Evaluate $\int_0^\pi \log sinx \; dx$.
2. (i). Evaluate $\int_0^\infty \frac{x^{\frac{1}{3}}}{1+x^2} dx$.

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

   (iii). Evaluate $\int_0^\infty \frac{sinx}{x} dx$.

Unit IV

1. Derive Poisson's Formula.
2. If $f(z)$ is analytic in the region Ω, containing z_0, then show that the following representation is valid in the largest open disk of centre z_0 contained in Ω.

$$f(z) = f(z_0) + \frac{f'(z_0)}{1!}(z - z_0) + \cdots + \frac{f^n(z_0)}{n!}(z - z_0)^n + \cdots$$

Unit V

1. The infinite product $\prod_{n=1}^{\infty}(1 + a_n)$ with $(1 + a_n) \neq 0$ converges simultaneously with the series $\sum_1^\infty \log(1 + a_n)$ whose terms represent the values of the principal branch of the logarithm.
2. Suppose $f(z)$ is holomorphic function with $f(0)$ is non-zero and $f(z)$ has zero at $a_1, a_2, \ldots, a_n$ inside $|z| < \rho$. Then $\log|f(0)| = -\sum_{k=1}^{n} \log\left(\frac{\rho}{|a_k|}\right) + \frac{1}{2\pi}\int_0^{2\pi} \log|f(\rho e^{i\theta})|\, d\theta$.

Head of the Department — Course Instructor

[Dr. T. Sheeba Helen] — [Dr. A. Anat Jaslin Jini]

Teaching Plan

Department : **Mathematics**
Class : **II M.Sc**
Title of the Course : **Core Course VIII : Topology**
Semester : **III**
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

Learning 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	Upon completion 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, countability axioms and completeness	PSO - 1	K1
CO - 2	defends the basic results in topological spaces, continuous functions, connectedness, compactness, countability and separation axioms and complete metric spaces	PSO -2	K2
CO - 3	solve problems on topological 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 - 4	K4
CO - 5	evaluate the comparison between different types of topological spaces	PSO - 4	K5

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

Unit	**Module**	**Topic**	**Teaching Hours**	**Cognitive level**	**Pedagogy**	**Assessment/ Evaluation**
I	**Topological space and Continuous functions**					
	1.	Definition of topology, discrete and indiscrete topology, finite complement topology, Basis for a topology and examples, Comparison of standard and lower limit topologies	4	K2	Introductory Session with PPT	Questioning
	2.	Order topology: Definition & Examples, Product topology on XxY: Definition & Theorem	4	K3	Lecture	Concept explanations
	3.	The Subspace Topology: Definition & Examples, Theorems	4	K2	Illustrative Method	Questioning
	4.	Closed sets: Definition & Examples, Theorems, Limit points: Definition Examples & Theorems , Hausdorff Spaces: Definition & Theorems	5	K1, K2	Seminar and Lecture	Recall simple definitions
	5.	Continuity of a function: Definition, Examples, Theorems, Homeomorphism: Definition & Examples, Rules for constructing continuous function, Pasting lemma & Examples, Maps into products	5	K1	Illustrative method and Discussion	Recall basic definition and concepts
II	**The Product Topology, The Metric Topology & Connected Spaces**					
	1.	The Product Topology: Definitions, Comparison of box and product topologies,	3	K4	Brainstorming	Debating

		Theorems related to product topologies, Continuous functions and examples				
	2.	The Metric Topology: Definitions and Examples, Theorems, Continuity of a function, The sequence lemma, Constructing continuous fuctions, Uniform limit theorem, Examples and Theorems	4	K2, K3	Discussion and Lecture	Slip test
	3.	Connected Spaces: Definitions, Examples, Lemmas and Theorems	3	K1, K3	Seminar and Flipped Classroom	Concept definitions
	4.	Components and Local Connectedness: Definitions, Path components, Locally connected, Locally path connected: Definitions and Theorems	4	K3, K4	Lecture with PPT	Recall steps
	5.	The Product Topology: Definitions, Comparison of box and product topologies, Theorems related to product topologies, Continuous functions and examples	4	K3, K4	Illustration method with PPT	Differentiate between various ideas
III	**Compactness**					
	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	5	K1 & K2	Seminar and flipped class room	MCQ
	2.	Compact Subspaces of the Real Line: Theorem,	5	K3 & K4	Lecture	Explain

		Characterize compact subspaces of R^n, Extreme value theorem, The Lebesgue number lemma, Uniform continuity theorem				
	3.	Limit Point Compactness: Definitions, Examples and Theorems, Sequentially compact	4	K1 & K3	Seminar and Discussion	Slip Test
	4.	Local compactness: Definition & Examples, Theorems	3	K1 & K2	Brainstorming	Quiz
IV	**Separation axioms**					
	1.	First Countability axiom, Second Countability axiom: Definitions, Theorems, Dense subset: Definitions & Theorem, Examples, Lindelof space : Definition, Examples	5	K3	Lecture	Differentiate between various ideas
	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	K3	Integrative method	Concept Explanation
	3.	Normal Spaces: Theorems and Examples	4	K1 & K2	Collaborative learning	Slip Test
	4.	Urysohn lemma	2	K2	Lecture Discussion	Questioning
V	**UrysohnMetrizationTheorem, Tietze Extension Theorem & Complete Metric Space**					
	1.	Urysohn metrization theorem, Imbedding theorem	4	K2	Seminar Presentation	Short test
	2.	Tietze extension theorem	4	K2	Seminar Presentation	Concept explanations

	3.	Complete Metric Spaces: Definitions, Examples and Theorems, Isometric embedding	5	K3 & K4	Lecture	Questioning
	4.	Compactness in Metric spaces: Totally bounded, Pointwise bounded, Equicontinuous, Definitions, Lemmas, Theorems	5	K3 & K4	Collaborative learning	Slip Test

Course Focussing on Employability/ Entrepreneurship/ Skill Development: **Employability**
Activities (Em/ En/SD): **Poster Presentation, Seminar Presentation, Group Discussion**
Course Focussing on Cross Cutting Issues (Professional Ethics/ Human Values/Environment Sustainability/ Gender Equity): -
Activities related to Cross Cutting Issues: -
Assignment: **Prove given results (Exercise problems in the text book)**
Seminar Topic: **Closed Sets, Limit Points, Continuity of a Functions, Connected Space and Dense Sets**

Sample questions

Part A

1. Which pair of topologies are not comparable?
   (i) $\mathbb{R}_l$ and $\mathbb{R}$
   (ii) $\mathbb{R}_k$ and $\mathbb{R}$
   (iii) $\mathbb{R}_l$ and $\mathbb{R}_k$
   (iv) None of the above

2. Let $f: A \to \prod_{\alpha\in J} X_\alpha$ be given by the equation $f(a) = (f_\alpha(a))_{\alpha\in J}$, where $f_\alpha: A \to X_\alpha$ for each α. If $\prod X_\alpha$ has the product topology, then f is continuous iff
   (i) At least one f_α is continuous
   (ii) At most one f_α is continuous
   (iii) Each f_α is continuous
   (iv) None of the above

3. Under which mapping the image of compact space is compact
   (i) Bijective mapping
   (ii) Injective mapping
   (iii) Continuous mapping
   (iv) Uniform continuous mapping

4. A space for which every open covering contains a countable subcovering is called a ________.

5. Say True or False: The Tietze extension theorem implies the Uryshon lemma.

Part B

1. Define order topology and give two examples for the same.
2. Let X be a metric space with metric d. Then prove that $\bar{d}: X \times X \rightarrow \mathbb{R}$ by $\bar{d}(x, y) = \min\{d(x, y), 1\}$ is a metric that induces the same topology as d.
3. Show that compactness implies limit point compactness.
4. Prove that every metrizable space is normal.
5. A metric space is complete iff every Cauchy's sequences has a convergent subsequences.

Part C

1. Let X be an ordered set in the order topology and Y be a subset of X that is convex in X. Then show that the order topology on Y is the same as the topology Y inherits as a subspace of X.
2. Prove that the topologies on $\mathbb{R}^n$ induced by the Euclidean metric d and the square metric ρ are the same as the product topology on $\mathbb{R}^n$.
3. State and prove the Lebesgue number lemma.
4. Prove that a subspace of a Hausdorff space is Hausdorff and a product of Hausdorff spaces is Hausdorff.
5. State and prove Urysohn meterisation theorem.

Head of the Department
Dr. T. Sheeba Helen

Course Instructor
Dr. M. K. Angel Jebitha

Teaching Plan

Department: Mathematics

Class: II M.Sc. Mathematics

Title of the Course: Core Course IX: Traditional Mechanics

Semester: III

Course Code: MP233CC3

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

Learning Objectives

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

Course outcomes

CO	Upon completion of this course, the students will be able to:	PSO addressed	Cognitive level
CO - 1	grasp concepts like time dilation, relativistic dynamics, and the equivalence principle.	PSO - 1	K4, K5
CO - 2	understand classical mechanics principles such as coordinates, constraints, and energy-momentum relationships for analyzing mechanical systems.	PSO - 2	K1, K2
CO - 3	apply Lagrangian methods to special cases such as impulsive motion and systems with constraints, thereby expanding their problem-solving abilities	PSO - 2	K3
CO - 4	integrate classical and relativistic mechanics, enabling them to analyze systems ranging from everyday mechanics to those involving high speeds and gravity.	PSO - 4	K3, K5
CO - 5	become proficient in using Lagrangian mechanics to solve complex problems and identify integral properties of motion.	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	**The Mechanical System**					
	1.	The Mechanical System	4	K1, K2	Recall the basic definitions	Questioning
	2.	Generalized coordinates, Constraints	5	K4, K5	Lecture with illustration	Summarize the concepts
	3.	Virtual work and D' Alembert's Principle	5	K2, K5	Illustrative Method	Questioning
	4.	Energy and Momentum	4	K2, K5	Lecture	Question and answer
II	**Lagrange's equations**					
	1.	Derivation of Lagrange's equations	6	K1	Brainstorming PPT	Questioning
	2.	Problems using Lagrange's equation	6	K2	Discussion and Lecture	Slip test
	3.	Integralsof the motion.	6	K2	Flipped Classroom	Q & A
III	**Special Applications of Lagrange's Equations**					
	1.	Special Applications of Lagrange's Equations, Rayleigh's Dissipation Function	5	K2	Lecture	Short test
	2.	Impulsive Motion, Impulsive and momentum	5	K3, K4	Lecture	Problem-solving
	3.	Lagrangian method, Ordinary constraints, Impulsive constraints	4	K3, K4	Lecture	Short test
	4.	Energy considerations- Quasi – coordinates. Examples	4	K3, K5	Lecture	Questioning
IV	**Introduction to Relativity**					

	1.	Introduction to Relativity, Introduction, Galilean transformation	2	K1 & K2	Brainstorming	Quiz
	2.	Maxwell's equations, The ether theory, The principle of relativity, Relativistic Kinematics	4	K3	Lecture	True/False
	3.	The Lorentz transformation equations, Events and simultaneity, Einstein's train, Time dilation-	4	K2	Lecture	Concept Explanation
	4.	Longitudinal contraction, the invariant interval, proper time and proper distance	4	K3, K4	Lecture with chalk and talk	Slip Test
	5.	The world line, the twin paradox, Addition of velocities, the relativistic Doppler effect	4	K2, K4	Lecture Discussion	Q& A
V	**Relativistic Dynamics**					
	1.	Relativistic Dynamics, Momentum, Energy	4	K2	Introductory Session	Explain
	2.	The momentum, energy four vector, Force, Conservation of energy, Mass and energy, inelastic collision	5	K2, K4	Lecture with illustration	Concept explanations
	3.	The principle of equivalence, Lagrangian and Hamiltonian formulations, Accelerated systems	5	K3, K4	Seminar Presentation	Questioning
	4.	Rocket with constant acceleration, Rocket with constant thrust	4	K2	Seminar Presentation	Recall steps

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

Activities (Em/ En/SD): **Problem-solving, Seminar Presentation, Group Discussion**

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

Activities related to Cross Cutting Issues: -

Assignment: **Solving Exercise Problems**

Seminar Topic: The principle of equivalence, Lagrangian and Hamiltonian formulations, Accelerated systems, Rocket with constant acceleration, Rocket with constant thrust**.**

Sample questions

Part A

1. The types of constraints are ------------

2. The generalized co-ordinates are ---------

Part B

1. Write about D'Alembert's principle.

2. A particle of mass m is connected by a massless spring stiffness k and unstressed length r_0 to a point p which moving along a circular path of radius a at a uniform angle rate ω. Assuming that the particle moves without friction on a horizontal plane, find the differential equation motion.

Part C

1. A rigid bar can rotate freely about a fixed pivot o and has a moment of inertia I about this point. a particle of mass m strikes the bar inelastically at time t_1 and slides along the bar after the impact. Solve for the velocities $\dot{x}, \dot{y}, \dot{\theta}$ after impact if the initial conditions are

$$x(t_1) = 1m \qquad y(t_1) = 1m \qquad \theta(t_1) = \frac{\pi}{4}$$

$$\dot{x}(t_1-) = 0 \qquad \dot{y}(t_1-) = 1m/\sec \qquad \dot{\theta}(t_1-) = 1rad/\sec$$

Let m=1Kg and I=10Kgm^2

2. Derive the Lagrange's equation of motion for holonomic system.

Head of the Department **Course Instructor**

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

Department : **Mathematics**

Class : **II M. Sc**

Title of the Course : **Elective Course V: a) ALGORITHMIC NETWORK ANALYSIS**
Semester : **III**

Course Code : **MP233EC1**

Course Code	L	T	P	Credits	Inst. Hours	Total Hours	Marks		
							CIA	External	Total
MP233EC1	4	-	-	3	4	60	25	75	100

Pre-requisite:

Understanding of basic data structures, algorithms, and graph theory concepts.

Learning Objectives:

1. To master fundamental algorithms and data structures, enabling efficient problem-solving.
2. To develop analytical skills for evaluating and implementing algorithms, addressing real-world challenges in various domains.

Course Outcomes

On the successful completion of the course, students will be able to:		
1.	recall and identify basic concepts and facts related to algorithms, data structures, and graph theory, including definitions, properties, and terminology.	**K1**
2.	demonstrate a solid understanding of the principles and theories including their applications in problem-solving and computational analysis.	**K2**
3.	apply algorithmic techniques to solve real-world problems efficiently.	**K3**
4.	analyze algorithms, data structures, and graph theory concepts to identify optimal solutions for computational problems.	**K4**
5.	represent graphs in a computer using different data structures.	**K5**

K1 - Remember; **K2** - Understand; **K3** – Apply; **K4** - Analyse; **K5** - Evaluate

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

Unit	Module	Topic	Teaching Hours	Cognitive level	Pedagogy	Assessment/ Evaluation
I	**An Introduction to Algorithms**					
	1.	Algorithmic Complexity	2	K1 & K2	Interactive Lecture and Discussion	MCQ
	2.	Search Algorithms	3	K3	Collaborative learning	Problem-Solving Exercise
	3.	Sorting Algorithms	3	K3	Problem solving, Peer tutoring	Questioning
	4.	Greedy Algorithms	2	K4	Collaborative Learning	Problem Solving
	5.	Representing Graphs in a Computer.	2	K5	Blended classroom	Hands-On Task
II	**Trees**					
	1.	Properties of trees	1	K1	Brainstorming	Worksheet
	2.	Depth-First Search	2	K2	Flipped Classroom	Short summary
	3.	Depth-First Search: A Tool for Finding Blocks	3	K3 & K5	Lecture Discussion	Concept definitions
	4.	Breadth-First Search	2	K3	Jigsaw Technique	Discussion
	5.	The Minimum Spanning Tree Problem – Kruskal's Algorithm, Prim's Algorithm.	4	K4	Interactive Lecture and Discussion	Interactive Exercise

III	**Paths and Distance in Graphs**					
	1	Distance in Graphs	4	K2	Lecture Discussion	Concept definitions
	2	Distance in Weighted Graphs	4	K3 & K4	Problem solving	Slip test
	3	The Center and Median of a Graph	4	K3	Lecture, Group discussion	Concept explanations
IV	**Networks**					
	1.	An Introduction to Networks	2	K1 & K2	Think-Pair-Share	Group Activity
	2.	The Max-Flow Min-Cut Theorem	2	K3	Problem-Based Learning	Differentiate between various ideas
	3.	A Max-Flow Min-Cut Algorithm	2	K3	Integrative method	Explain
	4.	Connectivity and Edge-Connectivity	3	K4	Collaborative learning	Slip Test
	5.	Menger's Theorem	3	K5	Gamification	Discussion
V	**Digraphs**					
	1.	Strong Digraphs	2	K1 & K2	Seminar Presentation	MCQ
	2.	Depth-First Search in Digraphs	2	K2 & K3	Seminar Presentation	Group Work
	3.	Depth-First Search Algorithm for Digraphs	2	K4 & K5	Seminar Presentation	Questioning
	4.	Strongly Connected Components	3	K3	Seminar Presentation	Recall steps
	5.	Tournaments	3	K3	Seminar Presentation	True/False

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

Activities (Em/ En/SD): **Shortest Path Relay, Connectivity Challenge**

Assignment: **Finding Blocks Using DFS**

Sample questions

Part A

1. What does algorithmic complexity measure?
   a) Storage space b) Number of computational steps
   c) Input data size d) Running time
2. Which of the following statements is true about the DFS algorithm?
   a) DFS always finds the shortest path between two vertices.
   b) DFS can be used to detect cycles in a graph.
   c) DFS visits vertices in level-order.
   d) DFS always visits vertices in decreasing order of their degrees.
3. Which condition must be satisfied for Dijkstra's Algorithm to be applicable?
   a) The graph must be a tree.
   b) The graph must be connected.
   c) All edge weights must be non-negative.
   d) The graph must be directed.
4. Which of the following statements is true about the edge-connectivity of the trivial graph?
   a) $\lambda(K_1) = 1$ b) $\lambda(K_1) = 0$
   c) $\lambda(K_1) = infinity$ b) $\lambda(K_1) = -1$
5. Say true or false: A tournament is transitive if and only if it is cyclic.

Part B

1. Apply the sequential search algorithm to determine whether the word DOOR appears on the list:

W(1) = ARROW	W(6) = HAND
W(2) = BALL	W(7) = LADDER
W(3) = CAR	W(8) = NET
W(4) = DOOR	W(9) = PAN
W(5) = FOOT	W(10) = TENT

2. Prove that every nontrivial tree contains at least two end-vertices.
3. Prove that every graph is the center of some connected graph.
4. State and prove the Max-Flow Min-Cut Theorem.
5. Prove that every tournament has a Hamiltonian path.

Part C

1. Explain the concept of a greedy algorithm and how it applies to solving the Knapsack problem.
2. Prove that Prim's algorithm produces a minimum spanning tree in a nontrivial connected weighted graph.
3. Explain Dijkstra's Algorithm.
4. Let N be a network with underlying digraph D. Prove that a flow f in N is a maximum flow if and only if there is no f-augmenting semipath in D.
5. Prove that a connected graph G is strongly orientable if and only if G contains no bridges.

Head of the Department | Course Instructor

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

Department : **Mathematics**

Class : **II M.Sc**

Title of the Course : Skill Enhancement Course 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**

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

Unit	Module	Topic	Teaching Hours	Cognitive level	Pedagogy	Assessment/ Evaluation
I	**Research Methodology**					
	1.	Research Methodology : An Introduction , Meaning of Research , Objectives of Research -	2	K2	Brainstorming	MCQ
	2.	Motivation in Research - Types of Research	1	K2	Lecture	Slip Test
	3.	Research Approaches - Significance of Research	2	K2	Lecture Discussion	Questioning
	4.	Research Methods versus Methodology - Research and Scientific Method - -	2	K4	Lecture	Questioning
	5.	Importance of Knowing How Research is Done - Research Process	1	K2	Collaborative learning	Concept explanations
	6.	Criteria of Good Research - Problems Encountered by Researchers in India	1	K2	Blended classroom	Evaluation through short test
II	**Defining the Research Problem**					
	1.	Selecting the Problem,	1	K4	Brainstorming	True/False

		Necessity of Defining the Problem				
	2.	Technique Involved in Defining a Problem - An Illustration	2	K2	Lecture with Illustration	Short summary
	3.	Research Design - Meaning of Research Design	1	K4	Lecture Discussion	Concept definitions
	4.	Need for Research Design - Research Methodology	1	K4	Group Discussion	Explain
	5.	Features of a Good Design - Important Concepts Relating to Research Design	1	K4	Flipped Classroom	Questioning
	6.	Different Research Designs - Basic Principles of Experimental Designs	1	K4	Blended classroom	MCQ
	7.	Developing a Research Plan.	2	K5	Peer Instruction	Slip Test
III	**Processing and Analysis of Data**					
	1.	Processing Operations	1	K2	Brainstorming	Quiz
	2.	Some Problems in Processing	2	K4	Lecture	Explain
	3.	Elements/Types of Analysis	2	K2	Lecture Discussion	Slip Test

	4.	Statistics in Research	1	K2	Lecture	Questioning
	5.	Measures of Central Tendency	1	K2	Collaborative learning	Questioning
	6.	Measures of Dispersion	1	K2	Poster Presentation	Concept explanations
	7.	Measures of Asymmetry (Skewness)	1	K2	Blended classroom	Overview
IV	**Research Project**					
	1.	Difference between a Dissertation and a Thesis	1	K2	Brainstorming	Quiz
	2.	Basic Requirements of a Research Degree – Deciding on a research topic	2	K4	Flipped Classroom	Differentiate between various ideas
	3.	Writing a proposal – Familiarity with Codes of Practice/ Rules and Regulations	2	K5	Integrative method	Explain
	4.	Ethical considerations - Different components of a Research Project	1	K4	Collaborative learning	Slip Test
	5.	Title page –Abstract – Acknowledgement	1	K2	Lecture Discussion	Questioning
	6.	List of Contents, Literature Review , Methodology,	2	K2	Lecture Discussion	Concept explanations

		Style of Presentation				
V	**Publishing and Presenting your Research and Tool kit**					
	1.	Journal Articles	2	K2	Seminar Presentation	MCQ
	2.	A book	2	K4	Seminar Presentation	Concept explanations
	3.	Conference Presentation	2	K2	Seminar Presentation	Questioning
	4.	A final note	1	K4	Seminar Presentation	Recall steps
	5.	All punctuations	2	K4	Seminar Presentation	True/False

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

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

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

Activities related to Cross Cutting Issues: -

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

Seminar Topic: **Unit V- Publishing and Presenting your Research and Tool kit**

SAMPLE QUESTIONS

Part A

1. What is the primary purpose of research?
   a. To generate new knowledge b. To confirm existing theories
   c. To promote personal opinions d. To entertain readers
2. Name one technique used in defining a research problem.
3. Common measures include mean, median, and mode.(Say True / False)

4. ------------ provides a concise summary of the research project, including its purpose, methods, results, and conclusions.
5. What challenges might researchers encounter during the publication process?
   a. manuscript rejection c. lengthy peer review processes
   b. difficulty finding suitable journals for publication d. All the above

Part B

1. Identify and analyze the common problems encountered by researchers in India.
2. Describe the necessity of research design in a research study.
3. Elaborate on the different types of analysis commonly used in research.
4. Discuss the process of deciding on a research topic, emphasizing the factors that researchers should consider. Provide practical advice on how researchers can select a suitable research topic within their field of study.
5. Explain the role of toolkits in research project management. How can researchers customize toolkits to suit their specific research needs?

Part C

1. Compare and contrast quantitative and qualitative research methods, highlighting their respective strengths and weaknesses. Provide examples of research studies that employ each approach.
2. Explain the basic principles underlying experimental designs and their significance in experimental research.
3. Critically analyze the role of statistics in research, discussing its importance in drawing meaningful conclusions from data analysis.
4. Examine the role and significance of each component of a research project, including the title page, abstract, acknowledgment, list of contents, introduction, literature review, methodology, and style of presentation. How do these components contribute to the overall coherence and professionalism of the research report?
5. Explore the components of writing a book based on research findings, including structuring the book, developing chapters, incorporating theoretical frameworks, and engaging with relevant literature. How does writing a book differ from writing journal articles in terms of scope, audience, and writing style?

Head of the Department **Course Instructor**

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