Holy Cross College (Autonomous), Nagercoil
Kanyakumari District, Tamil Nadu.
Accredited with A$^+$ by NAAC - IV Cycle – CGPA 3.35

Affiliated to
Manonmaniam Sundaranar University, Tirunelveli

DEPARTMENT OF MATHEMATICS

TEACHING PLAN (PG)

ODD SEMESTER

2025-2026

HOLY CROSS COLLEGE (Autonomous), NAGERCOIL

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 thinkinghumanistic 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.

Graduate Attributes

Graduates of our College develop the following attributes during the course of their studies.

- **Creative thinking:**
  Equipping students with hands-on-training through skill based courses and promote startup.
- **Personality development:**
  Coping with increasing pace and change of modern life through value education, awareness on human rights, gender issues and giving counselling for the needful.
- **Environmental consciousness and social understanding:**
  Reflecting upon green initiatives and understanding the responsibility to contribute to the society; promoting social and cultural diversity through student training and service learning programmes.
- **Communicative competence:**
  Offering effective communication skills in both professional and social contexts through bridge courses and activities of clubs and committees.
- **Aesthetic skills:**
  Engaging mind, body and emotions for transformation through fine arts, meditation and exercise; enriching skills through certificate courses offered by Holy Cross Academy.
- **Research and knowledge enrichment:**
  Getting in-depth knowledge in the specific area of study through relevant core papers; ability to create new understanding through the process of critical analysis and problem solving.
- **Professional ethics:**
  Valuing honesty, fairness, respect, compassion and professional ethics among students. The students of social work adhere to the *National Association of Social Workers Code of Ethics*
- **Student engagement in the learning process:**
  Obtaining extensive and varied opportunities to utilize and build upon the theoretical and empirical knowledge gained through workshops, seminars, conferences, industrial visits and summer internship programmes.
- **Employability:**
  Enhancing students in their professional life through Entrepreneur development, Placement & Career guidance Cell.
- **Women empowerment and leadership:**
  Developing the capacity of self-management, team work, leadership and decision making through gender sensitization programmes.

HOLY CROSS COLLEGE (Autonomous), NAGERCOIL

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 servingthe 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 theknowledge 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 guidepeople 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, socialand ethical responsibilities leading to sustainable development.	PEO3

Programme Specific Outcomes (PSOs)

PSOs	Upon completion of M.Sc. Degree Programme, the graduates ofMathematics will be able to:	POs Addressed
PSO1	acquire good knowledge and understanding, to solve specific theoretical& applied problems in different area of mathematics & statistics	PO1 & PO2
PSO2	understand, formulate, develop mathematical arguments, logically anduse quantitative models to address issues arising in social sciences, business and other context /fields.	PO3 & PO5
PSO3	prepare the students who will demonstrate respectful engagement with other's ideas, behaviors, beliefs and apply diverse frames of references todecisions and actions	PO6
PSO4	pursue scientific research and develop new findings with globalImpact using latest technologies.	PO4 & PO7
PSO5	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

HOLY CROSS COLLEGE (AUTONOMOUS) NAGERCOIL

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

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

Learning Objectives To understand the simple concepts of the theory of equations

1. 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:	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.	K1
CO-2	Define Solvable groups, define direct products, examine the properties of finite abelian groups, define modules	K2
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 nilpotent transformation relating nilpotence with invariants	K3
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.	K4
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 verify whether the transformation in Hermitian, unitary and normal	K5

TEACHING PLAN

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

Unit	Module	Topic	Teaching Hours	Assessment Hours	Cognitive level	Pedagogy	Student Centric Method	E-Resources	Assessment/ Evaluation Methods
I	**SYLOW'S THEOREMS**								
	1.	Counting Principle	4	1	K1 & K2	Brainstorming	Participative Learning through discussion and Q&A	YouTube Videos	MCQ, Qustioning **C**IA I
	2.	Class equation for finite groups	4	1	K2	Lecture with illustrations	Experiential learning through real life illustrations and Problem-solving tasks	E-notes, Video materials	Slip Test, class Test **C**IA 1
	3.	Class equation for finite groups and ts applications	4		K3	Problem Solving	Problem-solving in groups; Teach-back sessions	Power Point Presentation, E-notes, Video materials	Questioning, M**C**Q **C**IA 1
	4.	Sylow's theorems	6	1	K4	Lecture Discussion	Participative learning with application-based problems, experimental	Interactive Power Point Presentation,	Questioning, Quiz **C**IA 1

							learning via visual models		
II	**GROUP THEORY AND MODULES**								
	1.	Solvable groups	4	1	K1 & K2	Brainstorming	Participative Learning through discussion and Q&A	YouTube Videos	True/False Assignment **C**IA I
	2.	Direct products	5		K2	Flipped Classroom	Experiential learning through real life illustrations and Problem-solving tasks	E-notes, Video materials	Short summary **C**IA 1
	3.	Finite abelian groups	5	1	K2& K4	Lecture Discussion	Problem-solving in groups; Teach-back sessions	Power Point Presentation, E-notes, Video materials	Concept definitions **C**IA 1
	4.	Modules	4	1	K3	Problem Solving	Participative learning with application-based problems, experimental	Interactive Power Point Presentation,	Quiz **C**IA 1 Assignment

							learning via visual models		
III	**LINEAR TRANSFORMATION**								
	1.	Linear Transformations :	4	1	K1 & K2	Brainstorming	Participative Learning through discussion and Q&A	YouTube Videos	Quiz **C**IA 1
	2.	Canonical form	5	1	K2	Lecture with illustration	Experiential learning through real life illustrations and Problem-solving tasks	E-notes, Video materials	class Test **C**IA 1
	3.	Triangular form	4		K2	Lecture Discussion	Problem-solving in groups; Teach-back sessions	Power Point Presentation, E-notes, Video materials	Slip Test **C**IA II Assignment
	4.	Nilpotent transformations	5	1	K3	Problem Solving	Participative learning with application-based problems, experimental learning via visual models	Interactive Power Point Presentation,	Open book Test **C**IA II
IV	JORDAN AND RATIONAL CANONICAL FORMS								

	1.	Jordan form	4	1	K1 & K2	Brainstorming	Participative Learning through discussion and Q&A	YouTube Videos	Simple Questions **C**IA II
	2.	Differential equation of first order but of higher degree	5	1	K2	Blended Learning	Experiential learning through real life illustrations and Problem-solving tasks	E-notes, Video materials	Quiz **C**IA II Assignment
	3.	Equations solvable for p, x, y	5	1	K3	Integrative method	Problem-solving in groups; Teach-back sessions	Power Point Presentation, E-notes, Video materials	Explain the concept **C**IA II
	4.	rational canonical form	4		K1 & K2	Collaborative learning	Participative learning with application-based problems, experimental learning via visual models	Interactive Power Point Presentation,	Slip Test **C**IA II
V	**TRACE AND TRANSPOSE**								
	1.	Trace and transpose	4	1	K1 & K2	Flipped Classroom	Participative Learning through discussion and Q&A	YouTube Videos	MCQ **C**IA II

	2.	Hermitian transformation	5	1	K2	Lecture with illustration	Experiential learning through real life illustrations and Problem-solving tasks	E-notes, Video materials	Concept explanations **C**IA II
	3.	unitary, normal transformations	5	1	K2 & K3	Problem Solving	Problem-solving in groups; Teach-back sessions	Power Point Presentation, E-notes, Video materials	Questioning **C**IA II
	4.	Real quadratic form.	4		K2	Group Discussion	Participative learning with application-based problems, experimental learning via visual models	Interactive Power Point Presentation,	Recall steps **C**IA II Assignment Quiz

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

Activities (SD): **Seminar Presentation**

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

Activities related to Cross Cutting Issues: -

Assignment: Mention the last date to submit: **Applications of Sylow's Theorem (Due date: 02-09-2025**

Seminar Topics: **Trace and transpose- Hermitian, unitary, normal transformations, real quadratic form.**

Sample Questions

PART-A(5x1=5)

1. Compute N(12) of a group S_3 (CO1-U)
2. State True or False: $n(k)$ is defined by $p^{n(k)} \mid (p^k)!$ but $p^{n(k)+1} \nmid (p^k)!$ (CO2-U)
3. The number of Sylow 3-subgroup of a group S_3 is----------(CO3-R)
4. The matrix A is said to be a skew-symmetric matrix if ----------(CO4-U)

   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 ---------.(CO5-A)

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

PART-B (5 x 6 = 30)

1. Prove that a group of order p^2 (p= prime) is abelian.(CO1-A)
2. Define double coset of 2 sub groups A and B in a group G and prove that

   $$O(AxB) = \frac{O(A)O(B)}{O(A \cap xBx^{-1})}$$.(CO2-An)
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 T is not 0.(CO3-E)
4. Suppose that $V = V1 \oplus V2$ 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 $T2$is $p2(x)$ then prove that the minimal polynomial for T over F is the least common multiple of $p1(x)$ and $p2(x)$. (CO4-U)

5. If $T \in A(V)$ is Hermitian then prove that all its characteristic roots are real.(CO5-AN)

PART- C (5 x 12 =60)

1. State and prove Sylow's theorem.(CO1-AN)
2. Prove that the number of Sylow p-subgroups of G is of the form 1+kp where $(1+kp) \mid o(G)$ (CO2-E)
3. If A is an algebra, with unit element over F, then prove that A is isomorphic to a subalgebra of (V) for some vector space V over F. (CO3-An)
4. Prove that the elements S and T in $A(V)$ are similar in $AF(V)$ if and only if they have the same elementary divisors. (CO4-U)
5. Prove that the Hermitian linear transformation T is non negative iff its characteristic roots are nonnegative. (CO5-R)

Head of the Department

Dr. M.K. Angel Jebitha

Course Instructor

Dr. L. Jesmalar

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	S	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

On the successful completion of the course, students will be able to:		
1.	analyze and evaluate functions of bounded variation and rectifiable Curves.	**K4, K5**
2.	describe the concept of Riemann- Stieltjes integrals and its properties.	**K1, K2**
3.	demonstrate the concept of step function, upper function, Lebesgue function and their integrals.	**K3**
4.	construct various mathematical proofs using the properties of Lebesgue integrals and establish the Levi monotone convergence theorem.	**K3, K5**
5.	formulate the concept and properties of inner products, norms and measurable functions.	**K2, K3**

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

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

Unit	Module	Topic	Teaching Hours	Assessment Hours	Cognitive level	Pedagogy	Student Centric Method	E-Resources	Assessment/ Evaluation Methods
I	**FUNCTIONS OF BOUNDED VARIATION, INFINITE SERIES**								
	1	Definition of monotonic function connected and disconnected functions compact sets and examples	2	1	K2(U) & K4(An)	**Lecturing, Active Learning**	Think-Pair-Share, Peer Teaching, Discussions	*Video Lectures,* Slides	Quiz using Quizizz, Written Assignment, Oral Presentation, CIA I
	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	2		K4(An)	**Lecturing, Collaborative Learning**	Pause and solve, pose conceptual problems, learning circles, team-based learning	Video Lecture, Problem Bank	Conceptual Quiz, Group Presentation, CIA I
	3	Total variation – Definition, Behaviour of functions of	3	1	K4(An)	**Lecturing, Inquiry-**	Formulating questions, pause and	PowerPoint Presentation,	Quiz using google form,

		bounded variation, Example illustrating reciprocal of functions of total variation need not be of total variation, Additive property of total variation				**based Learning**	solve, pose conceptual problems, discussion on the materials referred.	YouTube Videos , E-notes	class test, Q & A, CIA I
	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 – Characterisation of functions of bounded variation, Continuous functions of bounded variation	3		K3(Ap)	**Lecturing, Flipped Classroom**	Applying concepts, working through problems, discussion on the materials referred	YouTube Videos, Interactive PPT	Written Assignment, Open Book Exam Questions, CIA I
	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	1	K4(An)	**Lecturing, Blended learning**	Online discussions, collaborative documents, online problem sets	Online Tutorials and Notes	Problem-Solving Assignments, Open Book Exam Questions, CIA I

	6	Rearrangement of series, Riemann's theorem on conditional convergent series	2		K3(Ap)	Lecturing, Differentiated instruction	Self-paced learning, peer sharing	YouTube videos, Quiz using quizizz	Quiz, viva, CIA I
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	1	K2(U) & K4(An)	**Lecturing, Active Learning**	Think-Pair-Share, Peer Teaching, Discussions	*Video Lectures,* Slides	Quiz using Quizizz, Written Assignment, Oral Presentation, CIA I
	2	Linear properties of Riemann - Stieltjes integral, Integration by parts, Connection between integrand and the integrator in a Riemann – Stieltjes integral	3		K3(Ap)	**Lecturing, Collaborative Learning**	Pause and solve, pose conceptual problems, learning circles, team-based learning	Video Lecture, Problem Bank	Conceptual Quiz, Group Presentation, CIA I
	3	Change of variable in a Riemann – Stieltjes integral, Reduction to a Riemann integral, Step functions as integrators, Example showing that the	3	1	K3(Ap)	**Lecturing, Inquiry-based Learning**	Formulating questions, pause and solve, pose conceptual problems, discussion on	PowerPoint Presentation, YouTube Videos	Quiz using google form, class test, Q&A, CIA I

		existence of integral can also be affected by a change					the materials referred.		
	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	3		K3(Ap)	**Lecturing, Flipped Classroom**	Applying concepts, working through problems, discussion on the materials referred	YouTube Videos, Interactive PPT, E-notes	Written Assignment, CIA I
	5	Definition – Upper and lower Stieltjes integral, upper and lower Riemann sums, Examples, Additive and linearity properties of upper and lower integrals, Riemann's	3	1	K4(An)	**Lecturing, Blended learning**	Online discussions, collaborative documents, online problem sets	Online Tutorials and Notes	Problem-Solving Assignments, Open Book Exam Questions, CIA I

		condition, Comparison theorems							
III	**THE RIEMANN - STIELTJES INTEGRAL**								
	1	Integrators of bounded variation, Sufficient conditions for existence of Riemann – Stieltjes integrals	3	1	K2(U) & K4(An)	**Lecturing, Active Learning**	Think-Pair-Share, Peer Teaching, Discussions	*Video Lectures,* Slides	Quiz using Written Assignment, Seminar Presentation, CIA I
	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	3		K4(An)	**Lecturing, Collaborative Learning**	Pause and solve, pose conceptual problems, learning circles, team-based learning	Video Lecture, Problem Bank	Conceptual Quiz, Group Presentation, Quiz using google form, CIA I
	3	Second fundamental theorem of fundamental calculus, Change of variable in a Riemann integral, Second Mean – Value	3	1	K4(An)	**Lecturing, Inquiry-based Learning**	Formulating questions, pause and solve, pose conceptual problems, discussion on	PowerPoint Presentation, YouTube Videos	class test, Q&A, CIA II

		theorem for Riemann integrals					the materials referred.		
	4	Riemann – Stieltjes integrals depending on a parameter, Differentiation under the integral sign	3		K3(Ap)	**Lecturing, Flipped Classroom**	Applying concepts, working through problems, discussion on the materials referred	YouTube Videos, Interactive PPT	Written Assignment, Open Book Exam Questions, CIA II
	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	3	1	K4(An)	**Lecturing, Blended learning**	Online discussions, collaborative documents, online problem sets	Online Tutorials and Notes	Problem-Solving Assignments, CIA II
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,	3	1	K4(An)	**Lecturing, Active Learning**	Think-Pair-Share, Peer Teaching, Discussions	*Video Lectures,* Slides	Written Assignment, Oral Presentation, CIA II

		Rearrangement theorem for double series, Definition – Rearrangement of double sequence							
	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	3		K4(An)	**Lecturing, Collaborative Learning, heuristic**	Pause and solve, pose conceptual problems, learning circles, team-based learning	Video Lecture, Problem Bank	Conceptual Quiz, Group Presentation, CIA II
	3	Cesaro Summability, Infinite products, Definition – infinite products, Cauchy condition for products	3	1	K4(An)	**Lecturing, Inquiry-based Learning**	Formulating questions, pause and solve, pose conceptual problems, discussion on the materials referred.	PowerPoint Presentation, YouTube Videos , E-notes	Quiz using google form, class test, Q&A, CIA II
	4	Power series, Definition – Power series, Multiplication of power series, Definition – Taylor's series	3		K3(Ap)	**Lecturing, Flipped Classroom**	Applying concepts, working through problems, discussion on	YouTube Videos, Interactive PPT	Written Assignment, Open Book Exam Questions, CIA II

							the materials referred		
	5	Abel's limit theorem, Tauber's theorem	3	1	K4(An)	**Lecturing, Blended learning**	Online discussions, collaborative documents, online problem sets	Online Tutorials and Notes	Problem-Solving Assignments, CIA II
V	**SEQUENCES OF FUNCTIONS**								
	1	Sequences of function – Pointwise convergence of sequence of function, Examples of sequences of real valued functions	3	1	K2(U) & K4(An)	**Lecturing, Active Learning**	Think-Pair-Share, Peer Teaching, Discussions	*Video Lectures,* Slides	Quiz using Quizizz, Written Assignment, Oral Presentation, CIA II
	2	Uniform convergence and continuity, Cauchy condition for uniform convergence	3		K2(U) & K4(An)	**Lecturing, Collaborative Learning, heuristic method**	Pause and solve, pose conceptual problems, learning circles, team-based learning	Video Lecture, Problem Bank	Conceptual Quiz, Group Presentation, CIA II
	3	Uniform convergence of infinite series of functions, Riemann – Stieltjes integration,	3	1	K2(U) & K4(An)	**Lecturing, Inquiry-based Learning**	Formulating questions, pause and solve, pose conceptual problems	PowerPoint Presentation, YouTube Videos	Quiz using google form, class test, Q&A, CIA II

	4	Non-uniform convergence and term-by-term integration	3		K3(Ap)	**Lecturing, Flipped Classroom**	Applying concepts, working through problems, discussion on the materials referred	YouTube Videos, Interactive PPT	Written Assignment, CIA II
	5	Uniform convergence and differentiation, Sufficient condition for uniform convergence of a series, Mean convergence	3	1	K2(U) & K4(An)	**Lecturing, Blended learning**	Online discussions, collaborative documents, online problem sets	Online Tutorials and Notes	Problem-Solving Assignments, Open Book Exam Questions, CIA I

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

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

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

Assignment: **Solving Exercise Problems (Late date for submission: 08.08.2025)**

Seminar Topics: **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 Marks)

1. Rectifiable arcs have _____ arc length. **(K1-R, CO-1)**

(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. **(K2-U, CO-2)**
3. State the first mean value theorem for Riemann Stieltjes Integral. **(K2-U, CO-3)**
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. **(K3-Ap, CO-4)**
5. Differentiate between pointwise convergence and uniform convergence. **(K2-U, CO-5)**

Part B (6 Marks)

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 $A = sup\{|g(x)| : x \in [a, b]\}$, $B = sup\{|f(x)| : x \in [a, b]\}$. **(K2-U, CO-1)**
2. Assume that $\alpha \nearrow$ on $[a, b]$. Then prove that $\underline{I}(f, \alpha) \leq \bar{I}(f, \alpha)$. **(K1-R, CO-2)**
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 $\int_a^b f(x)g(x)d\alpha\,(x) = \int_a^x f(x)dG\,(x) = \int_a^x g(x)dF\,(x)$. **(K1-R, CO-1)**
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 $(z) = \sum_{n=0}^{\infty} a_n(z - z_0)^n$, if $z \in B(z_0; r)$, is continuous on $B(z_0; r)$. **(K1-R, CO-1)**
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. **(K1-R, CO-1)**

Part C (12 Marks)

1. State and prove the additive property of total variation. **(K1-R, CO-1)**
2. State and prove the formula for integration by parts. **(K3-Ap, CO-2)**
3. State and prove the second fundamental theorem of integral calculus. **(K4-An, CO-3)**
4. State and prove Abel's limit theorem. **(K4-An, CO-4)**
5. State and prove Weierstrass M-test. **(K3-Ap, CO-5)**

Head of the Department
Dr. M. K. Angel Jebitha

Course Instructor
Antin Mary S

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

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP241CC3	5	1	–	–	5	6	90	25	75	100

Learning Objectives:

1. To develop proficiency in solving second-order linear ordinary differential equations using methods such as variation of parameters and power series solutions.
2. To solve systems of first-order linear differential equations with constant coefficients, understanding the existence and uniqueness of solutions.

Course Outcomes

On the successful completion of the course, students will be able to:		
1.	recall and describe the fundamental concepts of second-order linear ordinary differential equations, including homogeneous and non-homogeneous forms.	**K1**
2.	understand the method of variation of parameters for solving non-homogeneous second-order linear differential equations and illustrate its application through examples.	**K2**
3.	apply power series solutions to solve first and second-order linear ordinary differential equations, distinguishing between ordinary points and regular singular points.	**K3**
4.	analyze the stability and behaviour of solutions for systems of first-order linear differential equations with constant coefficients, identifying critical points and their implications.	**K4**
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.	**K5**

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

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

Unit	Module	Topic	Teaching Hours	Assessment Hours	Cognitive level	Pedagogy	Student Centric Method	E-Resources	Assessment/ Evaluation Methods
I	**SECOND ORDER HOMOGENEOUS EQUATIONS**								
	1	Second order homogeneous equations	3	1	K1(R) & K2 (U)	Lecture Method	Group Discussion	YouTube Video	Conceptual Questions, CIA I
	2	The general solution of a homogeneous equation	3		K2(U)	Collaborative learning	Peer Tutoring	YouTube Lectures	Quiz, Group Presentation, CIA I
	3	The use of a known solution to find another	3	1	K3(Ap)	Inductive Method	Collaborative Learning	Interactive PPT	Concept check polls during class using Slido, CIA I
	4	The method of variation of parameters	3		K3(Ap)	Problem Solving	Problem-Based Learning	-	Open Book Exam, CIA I
	5	Problems on the method of variation of parameters	3	1	K4(An)	Analytic Method	Peer Learning	-	Problem Solving Assignment, CIA I
II	**POWER SERIES SOLUTIONS AND SPECIAL FUNCTIONS**								
	1	Power series solutions and special functions	3	2	K1(R)	Blended classroom	Peer Instruction	YouTube Video	Peer Review, CIA I

	2	A review of power series	3		K2(U)	Flipped Classroom	Think Pair Share	YouTube Video	Peer discussions and concept maps, CIA I
	3	Series solutions of first- order equations	3	1	K3(Ap)	Integrative method	Mind map	-	Problem-Solving Assignments, CIA II
	4	Second-order linear equations	3		K3(Ap)	Analytic Method	Peer Teaching	Interactive PPT	Slip Test, CIA II
	5	Ordinary points – Regular singular points	3		K4(An)	Collaborative learning	Brainstorming	-	Q & A, CIA II
III	**SYSTEMS OF FIRST-ORDER EQUATIONS**								
	1	Systems of First-Order Equations	3	1	K1(R) & K3 (Ap)	Flipped Classroom	Heuristic Method	Video Lectures	Conceptual MCQs CIA II
	2	Linear Systems	3		K2(U)	Contextual Based Learning	Think Pair Share	Interactive PPT	Concept explanations, CIA II
	3	Problems on Linear Systems	3	1	K3(Ap)	Integrative method	Problem Based Learning	-	Slip Test, CIA II
	4	Homogeneous Linear Systems with Constant Coefficients.	3		K3(Ap)	Synthetic Method	Problem Solving	Interactive PPT	Quiz, CIA II

	5	Problems on Homogeneous Linear Systems with Constant Coefficients.	3	1	K4(An)	Lecture Method	Concept Mapping	YouTube Video	Peer discussion, CIA II
IV	**LEGENDRE POLYNOMIALS**								
	1	Legendre Polynomials	3	1	K1(R) & K2 (U)	Inquiry-Based Learning	Think-Pair-Share	YouTube Video	Conceptual Quiz, CIA II
	2	Properties of Legendre Polynomials	3		K2(U)	Contextual Based Learning	Logical reasoning	-	Conceptual Assignment, CIA II
	3	Bessel's Functions	3		K3(Ap)	Synthetic Method	Brainstorming	YouTube Video	Peer review of solved derivations, CIA II
	4	The Gamma Functions	3	1	K3(Ap)	Blended Learning	Creative thinking	-	Slip Test, CIA II
	5	Properties of Bessel Functions	3	1	K4(An)	Synthetic Method	Think Pair Share	-	Simple Questions, CIA II
V	**THE EXISTENCE AND UNIQUENESS OF SOLUTIONS**								
	1	The Existence and Uniqueness of Solutions	3	1	K1(R)	Heuristics Method	Concept Mapping	-	Conceptual quiz, CIA II
	2	The Method of Successive Approximations	3		K2(U)	Integrative method	Problem Based Learning	-	MCQs, CIA II
	3	Picard's Theorem	3		K3(Ap)	Flipped Classroom	Inquiry Based Learning	YouTube Video	Slip Test, CIA II

	4	Systems of the Second Order Linear Equations	3	2	K3(Ap)	Seminar Presentation	Creative thinking	-	Concept explanations, CIA II
	5	Problems on Systems of the Second Order Linear Equations	3		K4(An)	Seminar Presentation,Problem-Based Learning	Guided problem solving sessions	-	Discussion-based evaluation on implications, CIA II

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

Activities (Em / En /SD): **Hands on Training on Problem solving**

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

Assignment: **Problems on Systems of the Second Order Linear Equations**. (Last date to submit – example: 15-10-2025)

Seminar Topics: **The Existence and Uniqueness of Solutions, The Method of Successive Approximations, Picard's Theorem, Systems of the Second Order Linear Equations, Problems on Systems of the Second Order Linear Equations**

Sample questions

Part A

1. What is the degree of the ordinary differential equation $\sqrt{(y' + y)} = \sin x$? **(K1-R, CO-1)**

   a) 2 b) 3 c) 1 d) 4

2. What is the complementary function of the differential equation $(D^2 + 9) = \cos x$? **(K4-An, CO-4)**

   a) $y = Ae^{3x} \cos 3x$ b) $y = A\cos 3x + B\sin 3x$

c) y = $(A + B)\sin 3x$ d) y = $Acos^3x$ +Bsin^3x

3. What are the integrals of complementary function of the differential equation $y'' + Py' + Qy = X$ if $1 + P + Q = 0$? **(K3-Ap, CO-3)**

4. What does Charpit's method provide in the context of differential equations? **(K2-R, CO-2)**

   (a) a general method of solving any differential equation.
   (b) a general method of solving any partial differential equation.
   (c) general method of solving any partial differential equation of first order.
   (d) a general method of solving any partial differential equation of second order.

5. **State True or False:** The orthogonal trajectories of the family of circles $x^2+y^2 = a^2$ is the family of straight lines not passing through the origin. **(K3-Ap, CO-3)**

Part B (3 marks)

1. Solve $(x^2 + y^2 + x)x + xydy = 0$. **(K1-R, CO-1)**

2. Evaluate the particular integral of the differential equation $(D^2 + 9) = 4sin3x$. **(K4-An, CO-4)**

3. Solve $y''+ y = cosec\ x$ by the method of variation of parameters. **(K3-Ap, CO-3)**

4. Find the general solution of $p + 3q = 5z + \tan(y - 3x)$. **(K3-Ap, CO-3)**

5. Find the orthogonal trajectories of the family of curves given by $r = asin\theta$. **(K4-An, CO-4)**

PART-C

1. Solve $dy/dx = (x - y + 1)/(x + y + 3)$ **(K3-Ap, CO-3)**

2. Solve $(2x + 1)^2\ y''-2(2x + 1)y' - 12y = 6x$. **(K4-An, CO-4)**

3. By the method of variation of parameter solve $y'' - 2y' + y = e^x log x$. **(K3-Ap, CO-3)**

4. Solve $(p^2 + q^2) = qz$. **(K1-R, CO-1)**

5. A tank contains 100 litres of fresh water. Salt water which contains 2 grams of salt per litre flows into the tank at the rate of 2 litres per minute. The mixture runs out at the same rate. How long will it take for the quantity of salt in the tank to increase from 50 to 100 grams? **(K3-Ap, CO-3)**

Head of the Department **Course Instructor**

Dr. M. K. Angel Jebitha **Dr. V. Sujin Flower**

Department : Mathematics
Class : I M.Sc. Mathematics
Title of the Course : Elective Course I C): Programming in C++
Semester : I
Course Code : MP231EC3

Course Code	L	T	P	Credits	Inst. Hours	Total Hours	Marks		
							CIA	External	Total
MP231EC3	4	1	-	3	5	75	25	75	100

Learning Objectives

1. To apply mathematical concepts in programming
2. To create programs and applications

Course outcomes

CO	Upon completion of this course, the students will be able to:	Cognitive level
CO1	understand and analyze the concepts of tokens, expressions and control structures	**K1**
CO2	develop the knowledge in functions and arguments	**K2**
CO3	solve simple programs using classes and objects in C++	**K3**
CO4	apply the properties of constructors and destructors to solve programs	**K4**
CO5	create programs and applications using C++	**K5**

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

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

Unit	Module	Topic	Teaching Hours	Assessment Hours	Cognitive level	Pedagogy	Student Centric Methods	E-Resources	Assessment/ Evaluation
I	**BEGINNING WITH C++ & TOKENS, EXPRESSIONS AND CONTROL STRUCTURES**								
	1.	What is C++, Applications of C++	2	1	K1	Brainstorming & Discussion	Participative Learning: Students list real-life applications of C++	-	MCQ and Oral Q&A, CIA I
	2.	A simple C++ Programme, More C++ Statements, An Example with Class	2		K2 & K3	Case-Based Method, Problem-solving, Analytic Method	Group Discussion and presenting solution	Interactive Power Point Presentation, E-notes, Video Tutorials	Teach-back, Slip Test, Writing a basic C++ class-based program, CIA I
	3.	Structure of C++ Programme, Creating the Source File,	2		K2 & K3	Discussion, Synthetic Method,	Experiential Learning: Hands-on demo Simulation-	Power Point Presentation, E-notes, Video Tutorials	Think-Pair-Share, Questioning, Create and

		Compiling and Linking				Inductive Method	Based Exploration, Group Work and Presentations, Compare and Connect.		compile a program, CIA I
	4.	Token and Keyword, Identifiers and Constants	3	1	K1, K3 & K5	Heuristic Method, Inductive Method, Deductive Method	Hands on training, Peer Teaching, Concept mapping,	Interactive Power Point Presentation, E-notes, Video Tutorials, Interactive Quizzes	Interactive quizzes on tokens; identify errors Worksheets and Homework, CIA I
	5.	Basic Data Type, User-Defined Data Types & Control Structures	3	1	K1, K3 & K5	Chalk-and-talk, Flipped Classroom, Inquiry-Based Learning, Group Discussion	Participative Learning: Write code using loops and decision structures	Interactive Power Point Presentation, E-notes, Video Tutorials, Interactive Quizzes	Slip Test, Quiz and Short Coding writing, CIA I
II	**FUNCTIONS IN C++**								
	1.	Introduction	1	1	K1	Brainstorming & Discussion	Participative Learning: Students list	E-notes	Oral presentation, CIA I

							functions of C++		
	2.	The Main Function & Function Prototyping	2		K2, K3 & K5	Flipped Classroom, Case-Based Method, Problem-solving, Analytic Method	Experiential Learning: Simulation-Based Exploration, example from math	Power Point Presentation, E-notes, Video Tutorials	Short summary, Code Recalling, Quiz, CIA I
	3.	Call by Reference & Return by Reference	2	1	K2, K3 & K5	Chalk-and-talk, Flipped Classroom, Inquiry-Based Learning, Group Discussion	Participative Learning, Problem-solving. Code swap using call by reference	Power Point Presentation, E-notes, Video Tutorials	Concept explanation, Peer-assessed problem explanation, Mid-unit test, CIA I
	4.	Inline Functions, Defaults Arguments, Const Arguments & Function Overloading	4	1	K2, K3 & K5	Illustrative Method, Lecture, Collaborative Learning	Experiential Learning: Demonstrate function overloading Problem Solving	Power Point Presentation, E-notes, Video Tutorials, Live Demos	Debugging Code, Socrative Poll, CIA I

	5.	Friend and Virtual Functions & Math Library Functions	3		K2, K3 & K5	Inductive Method, Case-Based Method, Problem-solving, Analytic Method	Participative Learning, Problem-solving: Writing sample virtual function with output	Power Point Presentation, E-notes, Video Tutorials	Mini program Review, CIA I
III	**CLASSES**								
	1.	Introduction	1	1	K1	Flipped Classroom, Case-Based Method, Problem-solving, Analytic Method	Participative Learning: Write sample virtual function with output	E-notes	Quiz, CIA I
	2.	C Structures Revisited & Specifying a Class	2		K2 & K5	Chalk-and-talk, Programme Writing, Analytic Method, Inductive Method	Participative Learning: Converting C++ structure to C++ class	SLO, Power Point Presentation, E-notes, Video Tutorials, Live Demos	Concept-check quiz, Group Code writing, Reflective writing, CIA I
	3.	Defining Membership Functions & A	3		K2 & K5	Lecture with discussion, Deductive	Experiential Learning: Hands on	Power Point Presentation, E-notes, Video	Slip Test, Teach-back, Mini-

		C++ Program with Class				Method, Programme Writing, Group Discussion	training on class-based program	Tutorials, Live Demos	programme writing, CIA II
	4.	Making an Outside Function Inline & Nesting of Member Functions	3	1	K2 & K5	Socratic Method, Group Discussion, Problem-solving in groups	Experiential Learning: Nested function output, Peer teaching	Power Point Presentation, E-notes, Video Tutorials, Live Demos	Simple Programme Writing, CIA II
	5.	Private Member Functions & Arrays with a Class	3	1	K2 & K5	Problem-Solving Method, Heuristic Method, Deductive Method	Participative Learning: Group discussion, peer learning, Creatting a class handling student marks array	Power Point Presentation, E-notes, Video Tutorials, Live Demos	Small-group discussion around conceptual MCQs, CIA II
IV	**OBJECTS**								
	1.	Memory Allocation for Objects	2	1	K1	Brainstorming, Group Discussion	Participative Learning: Think- pair and share, Compare memory usage between objects	-	Think-Pair-Share. Small-group discussion, CIA II

	2.	Static Data Member & Static Member Functions	3		K1, K3 & K5	Chalk-and-talk, Case-Based Learning, Illustrative method, Flipped Classroom	Experiential Learning: Hands on training on Code static data member	SLO, Power Point Presentation, E-notes, Video Tutorials	Concept mapping, Recalling Steps, Recalling Formula, CIA II
	3.	Arrays of Objects, Objects as Function Arguments & Friendly Functions	3	1	K3 & K5	Illustrative method, Analytic Method, Socratic Method, Inductive Method, Problem-Solving Method	Participative Learning: Hands on training on programme Writing	Interactive PPT, E-notes, Video Tutorials, Live Demos	Recalling Formula, Home assessment, Group problem-solving, Write object array and use in function. CIA II
	4.	Returning Objects & Constant Member Functions	2		K1, K3 & K5	Collaborative learning, Project-Based Learning, Illustrative method, Flipped Classroom	Participative Learning: Hands on training on return object from function, Problem-solving	SLO, Power Point Presentation, E-notes, Video Tutorials, Live Demos	Worksheets, Assignment, Concept-check quiz, Assignment, CIA II

	5.	Pointers of Members & Local Classes	2	1	K1, K3 & K5	Chalk-and-talk, Case-Based Learning, Illustrative method	Experiential Learning: Demonstration on to create local class, Programme Writing, Group Coding Tasks	Power Point Presentation, E-notes, Video Tutorials, Live Demos	Writing mini member functions, Design Classes, Assignment, CIA II
V	**CONSTRUCTORS AND DESTRUCTORS**								
	1.	Introduction, Constructors & Parameterized Constructors	2	1	K4	Chalk-and-talk , Collaborative Learning, Flipped Classroom	Participative Learning: Programme writing with constructors, Debugging code, Discussion, Problem-solving	Power Point Presentation, E-notes, Video Tutorials, Live Demos	Collaborative worksheet, Peer-assessed problem explanation, CIA II
	2.	Multiple constructors in a class & Constructors with Default Arguments	3		K4	Socratic Method, Group Discussion, Problem-solving in groups	Experiential learning: Hands on training on the usage of multiple constructors, Discussions, peer learning	Power Point Presentation, E-notes, Video Tutorials, Live Demos	Concept explanations, Oral presentation of multiple constructors and run the programme and identifying errors, CIA II
	3.	Dynamic Initialization of	3	1	K4 & K5	Lecture with	Problem-solving: Group	Power Point Presentation, E-	Questioning, Mid-unit test,

		Objects & Copy Constructor				illustration, Analytic Method, Socratic Method, Inductive Method	work, Project based learning in copy constructor by duplicate object	notes, Video Tutorials, Live Demos	Concept-check, Group quiz, CIA II
	4.	Dynamic Constructors– Constructing Two & Dimensional Arrays	2	1	K4 & K5	Chalk-and-talk , Problem-Solving Method, Heuristic Method, Deductive Method	Participative Learning: Coding to create 2D dynamic array, Peer learning	Power Point Presentation, E-notes, Video Tutorials, Live Demos	Recall steps, Teach-back, Open Seminar, Home Assessment, CIA II
	5.	Constant Objects & Destructors	2		K4 & K5	Live Coding, Programming by demonstration	Experimental Learning: Demonstration on destructor execution order, Debugging code	Power Point Presentation, E-notes, Video Tutorials, Live Demos	Teach-back, Simple code Recalling, CIA II

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

Activities (Em/ En/SD): **Poster Presentation and Short Video Presentation**

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

Assignment: **Pointers of Members & Local Classes (Due Date 01-09-2025)**

Seminar Topic: **Constructors and Destructors**

Sample questions

Part A (1 Mark)

1. Which of the following is not a C++ token? **(K1-R, CO-1)**

a) Keywords b) Constants c) Operators d) Arrays

2. What is the keyword used to define an inline function? **(K2-U, CO-2)**

a) define b) inline c) static d) call

3. Identify the statement: A class can have multiple constructors with different parameters. (True/False)**(K2-U, CO-2)**
4. Recognize the keyword used for inheritance in C++ **(K2-U, CO-2)**

a) class b) extends c) virtual d) : (colon)

5. Fill**:** Operator overloading is done using the _____ keyword **(K1-R, CO-1)**

Part B (6 Marks)

1. Classify the different data types in C++. **(K4-An, CO-4)**
2. Differentiate between overloaded functions and inline functions **(K2-U, CO-2)**
3. Explain how the 'this' pointer works in C++ **(K3-Ap, CO-3)**
4. Explain why constructors are not inherited **(K4-An, CO-4)**
5. Explain the concept of operator overloading with an example. **(K4-An, CO-4)**

Part C (12 Marks)

1. Compare entry-controlled and exit-controlled loops with examples.**(K2-U, CO-2)**

2. Evaluate the benefits and limitations of using default arguments. **(K2-U, CO-2)**
3. Construct a class named Rectangle with private data members and public member functions to calculate area and perimeter. **(K3-Ap, CO-3)**
4. Critique the use of virtual base classes with examples **(K5-E, CO-5)**
5. Describe the advantages of polymorphism in object-oriented system **(K4-An, CO-4)**

Head of the Department

Dr. M.K. Angel Jebitha

Course Instructor

Dr. S.Sujitha

Department : Mathematics
Class : I M.Sc Mathematics
Title of the Course : ELECTIVE COURSE 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:	Cognitive level
CO - 1	understand the definition of Fuzzy sets and its related concepts	K1(R), K2(U)
CO - 2	define Fuzzy Graphs and can explain the concepts	K3(Ap)
CO - 3	explain the concepts in Fuzzy sets and its relations	K3(Ap)
CO - 4	discuss about Fuzzy logic	K2(U)
CO - 5	analyze the compositions of Fuzzy sets.	K4(An)

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

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

Unit	Module	Topic	Teaching Hours	Assessment Hour	Cognitive level	Pedagogy	Student Centric Method	E-Resources	Assessment/ Evaluation Methods
I	**Fundamental Notions**								
	1	Review of set theory and characteristic functions	1	1	K1(R)	Lecture, Socratic Questioning, Interactive Problem Solving	Think-Pair-Share, quick scenario analysis , Group Discussion	PPT, Video Lectures, Online Notes	Quiz, Written Assignment, Oral Presentation, CIA I
	2	Definition and concept of fuzzy subsets	3		K2(U)	Lecture, Visual Aids, Problem Solving	Peer Teaching, Jigsaw Method, Guided Worksheets	PPTs, Video Lectures, Interactive Apps	Quiz, Worksheet, Oral Presentation, CIA I
	3	Membership functions and their properties	3	1	K4(An)	Collaborative Group Work, Inquiry-Based Learning	cooperative activities involving pairs and small groups, Group Presentations	PPT, Video Lectures, Online Notes	Simple definitions, MCQ, Recall steps, Concept definitions, CIA I
	4	Comparison between crisp and fuzzy sets	3		K4(An)	Collaborative Learning	Think-Pair-Share, Peer Learning	PPT Presentation	Evaluation through short test, Information gap activities and problem-

									solving tasks, CIA I
	5	Examples and applications of fuzzy subsets	2	1	K3(Ap)	Lecture with Illustration , Problem-Based Learning	Peer Teaching, Think-Pair-Share, Discussion	Video Lectures	Quizziz, solving complex problems, CIA I
II	**Fuzzy Graphs**								
	1.	Definition and types of fuzzy graphs	2	1	K1(R)	Lecture, Visual Aids, Problem Solving	Think-Pair-Share, Peer Teaching, Group Discussion	PPT, Video Lectures, Online Notes	Quiz, Written Assignment, Oral Presentation, CIA I
	2.	Operations on fuzzy graphs	3		K2(U)	Inquiry-Based Learning, Jigsaw Method	Formulating questions, discussing research plans, Concept Mapping	PPT Presentation	Quiz, Worksheet, Group Presentation, CIA I
	3.	Representation of fuzzy graphs	2	1	K2(U)	Lecture with Illustration, Flipped Classroom	In-class discussions, group activities, Q&A with instructor	Video Lectures, Online Notes	Evaluation through quiz test using quizziz, MCQ, Recall steps, CIA I
	4.	Applications of fuzzy graphs in decision making	3	1	K3(Ap)	Lecture, Visual Aids, Problem Solving	Think-Pair-Share, Peer Teaching, Collaborative problem-solving sessions	PPT, Video Lectures, Online Notes	Quiz, Written Assignment, Oral Presentation, CIA I

	5.	Fuzzy graph algorithms and connectivity	2		K4(An)	Lecture, Socratic Questioning, Interactive Problem Solving	Peer Teaching, Think-Pair-Share, Discussion	Video Lectures	Quiz test, CIA I
III	**Fuzzy Relations**								
	1.	Definition and properties of fuzzy relations	2	1	K1(R)	Lecture, Socratic Questioning, Interactive Problem Solving	Think-Pair-Share, Peer Teaching, Group Discussion	PPT, Video Lectures, Online Notes	Quiz, Written Assignment, Oral Presentation, CIA I
	2.	Composition of fuzzy relations	3		K2(U)	Lecture, Visual Aids, Problem Solving	Peer Teaching, Jigsaw Method, Guided Worksheets	PPTs, Video Lectures, Interactive Apps	Quiz, Worksheet, Oral Presentation, CIA I
	3.	Inverse and reflexive fuzzy relations	2	1	K2(U)	Collaborative Group Work, Inquiry-Based Learning	Debates, Group Presentations	PPT, Video Lectures, Online Notes	Simple definitions, MCQ, Recall steps, Concept definitions, CIA II
	4.	Transitive closure and fuzzy equivalence relations	3	1	K4(An)	Lecture with Illustration, Problem-Based Learning	Think-Pair-Share, Peer Learning, brainstorming	PPT Presentation	Evaluation through short test, CIA II

	5.	Applications of fuzzy relations in data analysis	2		K3(Ap)	Blended Learning, Gamification	Online discussions, collaborative documents, Applying skills in a game context	Video Lectures	Quizz test, CIA II
IV	**Fuzzy Logic**								
	6.	Propositional logic and fuzzy logic basics	2	1	K1(R)	Lecture, Problem Solving, Blended Learning	Online problem sets, collaborative problem-solving tools, Peer Teaching, Group Discussion	PPT, Video Lectures, Online Notes	Quiz, Written Assignment, Oral Presentation, CIA II
	7.	Laws and operations in fuzzy logic	3		K2(U)	Lecture with Visual Aids, Jigsaw Method, Inquiry-Based Learning	Think-Pair-Share, Formulating questions, discussing research plans	PPT Presentation	Quiz, Worksheet, Group Presentation, CIA II
	8.	Implication and inference in fuzzy logic	3	1	K4(An)	Lecture with Illustration, Flipped Class, Concept Mapping	In-class discussions, group activities, Q&A with instructor	Video Lectures, Online Notes	Evaluation through quiz test using quizziz, Seminar, MCQ, Recall steps, CIA II

	9.	Fuzzy reasoning and approximate reasoning	2	1	K4(An)	Lecture, Problem-Based Learning	Think-Pair-Share, Peer Teaching, solving complex problems	PPT, Video Lectures, Online Notes	Quiz, Written Assignment, Oral Presentation, CIA II
	10.	Applications in control systems and AI	2		K3(Ap)	Lecture, Socratic Questioning, Interactive Problem Solving	Peer Teaching, Think-Pair-Share, Discussion	Video Lectures	Slip Test, CIA II
V	**The Laws of Fuzzy Composition**								
	11.	Composition of fuzzy sets and relations	2	1	K1(R)	Lecture, Socratic Questioning, Interactive Problem Solving	Think-Pair-Share, Peer Teaching, Group Discussion	PPT, Video Lectures, Online Notes	Quiz, Written Assignment, Oral Presentation, CIA II
	12.	Max-min and max-product compositions	2		K2(U)	Lecture, Visual Aids, Problem Solving	Peer Teaching, Jigsaw Method, Guided Worksheets	PPTs, Video Lectures, Interactive Apps	Quiz, Worksheet, Oral Presentation, CIA II
	13.	Associativity and commutativity in fuzzy compositions	3	1	K4(An)	Collaborative Group Work, Inquiry-Based Learning	Debates, Group Presentations	PPT, Video Lectures, Online Notes	Simple definitions, MCQ, Recall steps, Concept definitions, CIA II

	14.	Fuzzy equivalence and compatibility relations	3	1	K4(An)	Lecture with Illustration, Flipped Classroom	Think-Pair-Share, Peer Learning, In-class discussions, group activities, Q&A with instructor	PPT Presentation	Evaluation through short test, CIA II
	15.	Applications in fuzzy decision making	2		K3(Ap)	Lecture with Illustration , Group Discussion,	Peer Teaching, Think-Pair-Share, Discussion	Video Lectures	Slip Test using Quizziz, CIA II

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

Activities (Em/ En/SD): **Gamified quiz using fuzzy terms and concepts**

Assignment : **Solving Problems on Fuzzy Logic** (Last date to submit: 26-09-2025)

Seminar Topic: **Laws of Fuzzy Composition**

Sample questions

Part A (1 mark)

1. The fuzzy intersection is computed using . . . . . .
   a) Sum b) Product c) Maximum d) Minimum
2. A fuzzy graph is a pair . . . . . .
   a) (V, E) b) (V, μ) c) (V, μ_V, μ_E) d) (μ_V, μ_E)
3. A fuzzy relation is defined on:

a) Single set b) Cartesian product of sets c) Set of numbers d) A real line

4. Fuzzy logic deals with . . . . .

a) True and false only b) Degrees of truth c) Probability d) Boolean operations

5. The composition of fuzzy relations uses . . . . .

a) Logical OR b) Arithmetic Mean c) Max-Min operations d) Sum of squares

Part B (3 marks)

1. State and prove Decomposition Theorem.
2. Define a fuzzy graph with example.
3. What are reflexive, symmetric and transitive fuzzy relations?
4. Explain the truth value and its range in fuzzy logic.
5. Write short notes on transitive closure in fuzzy systems.

Part C (7 marks)

1. Explain the concept of fuzzy subset with suitable examples and notations.

2. Discuss union, intersection, and complement of fuzzy graphs.

3. Discuss fuzzy relation properties: reflexivity, symmetry and transitivity.

4. Define fuzzy logic and explain all logical operations with examples.

5. Prove and illustrate the associative law in fuzzy composition.

Head of the Department
Dr. M. K. Angel Jebitha

Course Instructor
Dr. A. Jancy Vini

Department : Mathematics
Class : II M. Sc. Mathematics
Title of the Course : Core Course VII : Complex Analysis
Semester : III
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

Learning 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:	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.	K2, K3
CO - 2	analyze the local properties of analytic functions, including removable singularities, zeros, poles, and the Maximum Principle.	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.	K3, K5
CO - 4	construct power series expansions using Weierstrass's Theorem and apply partial fractions and factorization techniques to manipulate complex functions.	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.	**K3, K4**

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

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

Unit	Module	Topic	Teaching Hours	Assessment Hours	Cognitive Level	Pedagogy	Student Centric Method	E-Resources	Assessment/ Evaluation Methods
I	**COMPLEX INTEGRATION AND CAUCHY'S INTEGRAL FORMULA**								
	1.	Line Integrals	2	1	K2(U)	Interactive Method Synthetical Method	Interaction Lateral Thinking Think-Aloud Memory Game	E-material Interactive PPT Video Lectures Zoom Google Classroom LMS Kahoot	Questioning Quiz Game Concept Explanation One Minute Paper CIA I
	2.	Rectifiable Arcs	1		K2(U)	Illustrative Method	Visualize the Concept Narration of the Problem	E-material Interactive PPT Video Lectures Zoom LMS Google Classroom	Concept Explanation Exit Ticket CIA I
	3.	Line Integrals as Functions of Arcs	3		K2(U)	Analytical Method Heuristic Method	Breakdown the Problem Creating Solutions	E-material Interactive PPT Video Lectures Zoom LMS	Construction of Proof Dictation Problem Solving Slip Test

								Google Classroom	Exit Ticket CIA I
	4.	Cauchy's Theorem for a Rectangle	2	1	K2(U), K3(Ap)	Constructive Method Socratic Method Illustrative Method Demonstration Case Studies	Mind Map Describing Method Lateral Thinking Interaction Analyze the Problem Peer Teaching	E-material Interactive PPT Video Lectures Zoom LMS Google Classroom	Proof Recitation Step-by-step Solutions Class Test Concept Cartoon CIA I
	5.	Cauchy's Theorem in a Disk	1		K2(U), K3(Ap)	Inquiry based Learning Algorithmic Approach Illustrative Method Demonstration	Think-pair-share Jigsaw Method Breakdown the Problem Lateral Thinking	E-material Interactive PPT Video Lectures Zoom LMS Google Classroom	Deriving Steps Proof Relay Generate Solutions Concept Mapping Exit Ticket CIA I
	6.	The index of a point with respect to a curve	3	1	K3(Ap)	Illustrative Method Inductive Method	Visualize the Concept Think-pair-share	E-material Interactive PPT Video Lectures Zoom Quizziz LMS Google Classroom	Quiz Concept Relay Match the Following – Gamma Exit Ticket CIA I
	7.	Cauchy's Integral formula	2		K3(Ap)	Deductive Method Heuristic Method	Mind Map Creative Thinking Jigsaw Method	E-material Interactive PPT Video Lectures Zoom	Recall Steps Proof Generating

							Proof Drafting	LMS Google Classroom	Step-by-step Solutions Slip Test Exit Ticket CIA I
	8.	Higher Derivatives	3		K3(Ap)	Constructive Method Algorithmic Approach	Breakdown the Problem Analyze the Situation Mind Map	E-material Interactive PPT Video Lectures Zoom LMS Google Classroom Flip Classroom	Step-by-step Solutions Explanation Questioning Exit Ticket CIA I
II	**LOCAL PROPERTIES OF ANALYTIC FUNCTIONS AND THE GENERAL FORM OF CAUCHY'S THEOREM**								
	1.	Local Properties of Analytic Function	2	1	K4(An)	Flipped Classroom Interactive Method Synthetical Method	Discussion on the Materials Referred Interaction Creating Solutions Analyze the Problem Lateral Thinking	E-material Interactive PPT Video Lectures Zoom LMS Google Classroom	Concept Sharing Proof Idea Generating Theorems Recitation Exit Ticket CIA I
	2.	Zeros and Poles	2		K4(An)	Brainstorming Interactive Method Heuristic Method Deductive Method Socratic Method	Brainstorming Interaction Lateral Thinking Using Techniques for	E-material Interactive PPT Video Lectures Zoom LMS	Concept Sharing Generate Solutions Problem Solving Quiz Game Exit Ticket

							Solving Problems	Google Classroom	CIA I
	3.	The Local Mapping	2	1	K4(An)	Computational Thinking Inquiry based Learning Socratic Method	Breakdown the Problem Lateral Thinking Jigsaw Method	E-material Interactive PPT Video Lectures Zoom Socrative LMS Google Classroom	Questioning Proof Explanation Concept Sharing MCQ Exit Ticket CIA I
	4.	The Maximum Principle	2		K4(An)	Brainstorming Flipped Classroom Deductive Method Debate	Brainstorming Discussion on the Materials Referred Using Techniques for Solving Problems Think-pair-share	E-material Interactive PPT Video Lectures Zoom LMS Google Classroom	Deriving Steps for Proof Relay Race Concept Mapping Exit Ticket CIA I
	5.	Chains and Cycles	2	1	K4(An)	Flipped Classroom	Discussion on the Materials Referred	E-material Interactive PPT Video Lectures Zoom Google Form LMS Google Classroom	Quiz Questioning Exit Ticket CIA I
	6.	Simple Connectivity	2		K4(An)	Algorithmic Approach	Breakdown the Problem	E-material Interactive PPT	Slip Test

						Demonstration	Mind Map Concept Mapping	Video Lectures Zoom LMS Google Classroom	Step-by-step Solutions Slip Test Exit Ticket CIA I
	7.	Homology, The General Statement of Cauchy's Theorem	2		K4(An)	Flipped Classroom Interactive Method	Discussion on the Materials Referred Interaction Mind Map Analyze the Problem	E-material Interactive PPT Video Lectures Zoom LMS Google Classroom Flip	Proof Writing Concept Mapping CIA I
III	**THE CALCULUS OF RESIDUES AND HARMONIC FUNCTIONS**								
	1.	The Residue Theorem	3	1	K5(E)	Computational Thinking Algorithmic Approach Analytical Method Socratic Method	Breakdown the Problem Using Techniques for Solving Problem Jigsaw Method Analyze the Situation Error Analysis	E-material Interactive PPT Video Lectures Zoom LMS Google Classroom Google Form	Concept Sharing Questioning Problem Solving Quiz Slip Test Concept Cartoon CIA I
	2.	The Argument Principle	2		K3(Ap)	Inductive Method Deductive Method Inquiry based Learning	Lateral Thinking Analyze the Problem Deriving Proof	E-material Interactive PPT Video Lectures Zoom LMS	Proof Deriving Concept Mapping Theorems Recitation Slip Test

								Google Classroom	Exit Ticket CIA I
	3.	Evaluation of Definite Integrals	6	1	K5(E)	Problem based Learning Lecture with Illustration Demonstration Computational Thinking Algorithmic Approach Problem Solving Heuristic Method	Lateral Thinking Breakdown the Problem Solving Problems Using Techniques for Solving Problems Case Studies Analyze the Problem Jigsaw Method	E-material Interactive PPT Video Lectures Zoom LMS Google Classroom	Problem Solving Relay Race Assignment Generate Solutions Step-by-step Solutions Questioning Assignment Overleaf Proof Submission CIA I
	4.	Definition and Basic Properties of Harmonic Functions	3	1	K3(Ap)	Flipped Classroom Synthetical Method Deductive Method	Discussion on the Materials Referred Creating Solution Deriving Proof	E-material Interactive PPT Video Lectures Zoom LMS Google Classroom Kahoot	Concept Sharing Generating Proof Quiz Game Concept Relay Exit Ticket CIA II
	5.	The Mean-Value Property	3		K3(Ap), K5(E)	Inquiry based Learning Algorithmic Approach Socratic Method	Breakdown the Problem Analyze the Problem Interaction	E-material Interactive PPT Video Lectures Zoom, Flip LMS, Socrative Google Classroom	Questioning Slip Test Quiz Class Test Exit Ticket CIA II

IV	**HARMONIC FUNCTIONS AND POWER SERIES EXPANSIONS**								
	1.	Poisson's Formula	3	1	K3(Ap)	Analytical Method Illustrative Method Computational Thinking	Jigsaw Method Using Techniques for Solving Problems Interaction	E-material Interactive PPT Video Lectures Zoom LMS Google Classroom	Concept Sharing Generate Solutions Questioning Exit Ticket CIA II
	2.	Schwarz's Theorem	2		K3(Ap)	Algorithmic Approach Analytical Method	Breakdown the Problem Analyze the Situation Jigsaw Method	E-material Interactive PPT Video Lectures Zoom LMS Google Classroom	Slip Test Questioning Concept Explanation Exit Ticket CIA II
	3.	The Reflection Principle	2	1	K3(Ap)	Flipped Classroom Brainstorming Interactive Method	Discussion on the Materials Referred Brainstorming Think-pair-share	E-material Interactive PPT Video Lectures Zoom LMS Google Classroom Kahoot	Quiz Game Concept Explanation Concept Relay Exit Ticket Open Book Test CIA II
	4.	Weierstrass's Theorem	2		K3(Ap)	Synthetical Method Inductive Method Inquiry based Learning Flipped Classroom	Lateral Thinking Mind Map Proof Narration Creating Solutions	E-material Interactive PPT Video Lectures Zoom LMS	Quiz Class Test Questioning Proof Idea Construction Exit Ticket

							Discussion on the Materials Referred	Google Classroom Mentimeter	CIA II
	5.	The Taylor's Series	3	1	K6(C)	Brainstorming Flipped Classroom Interactive Method Inductive Method	Discussion on the Materials Referred Think-pair-share Interaction Visualization	E-material Interactive PPT Video Lectures Zoom LMS Google Classroom	Construction of Examples Recall Steps Assignment Problem Solving Assignment Exit Ticket CIA II
	6.	The Laurent Series	3		K6(C)	Brainstorming Flipped Classroom Interactive Method	Discussion on the Materials Referred Group Discussion Jigsaw Method Interaction	E-material Interactive PPT Video Lectures Zoom LMS Google Classroom Flip	Construction of Examples Proof Writing Recall Steps Assignment Problem Solving Exit Ticket CIA II
V	**PARTIAL FRACTIONS AND FACTORIZATION AND ENTIRE FUNCTIONS**								
	1.	Partial Fraction	3	1	K4(An)	Socratic Method Inquiry based Learning	Creating Proof Ideas Lateral Thinking Think-pair-share Guided Library References	E-material Interactive PPT You Tube Videos Google Classroom	Presentation Slip Test Exit Ticket Open Book Test CIA II
	2.	Infinite Products	2	1	K4(An)	Heuristic Method Illustrative Method	Lateral Thinking Think-pair-share	E-material Interactive PPT	Presentation Surprise Test Exit Ticket

							Describing Proof Guided Library References	You Tube Videos Google Classroom	CIA II
	3.	Canonical Products	2		K3(Ap)	Illustrative Method Deductive Method	Using Techniques for Solving Problem Lateral Thinking Interaction Guided Library References	E-material Interactive PPT You Tube Videos Google Classroom	Presentation Concept Explanation Exit Ticket CIA II
	4.	Jensen's Formula	2	1	K4(An)	Algorithmic Approach Inquiry based Learning	Breakdown the Problem Analyze the Problem Creating Solutions Think-pair-share Mind Map Guided Library References	E-material Interactive PPT You Tube Videos Google Classroom	Presentation Proof Narration Exit Ticket Open Book Test CIA II
	5.	Hadamard's Theorem	3		K4(An)	Algorithmic Approach Demonstration Debate	Breakdown the Problem Analyze the Problem Peer Review Think-pair-share Mind Map Guided Library References	E-material Interactive PPT You Tube Videos Google Classroom	Presentation Step-by-step Solutions Peer Grading Exit Ticket CIA II

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 (Last date to submit – 08-09-2025)

Seminar Topics: Partial Fraction, Infinite Products, Canonical Products, Jensen's Formula, Hadamard's Theorem

Sample questions

Part A (1 mark)

1. The winding number of a point inside the circle is **(K3-Ap, CO-1)**
   (i) 1 (ii) 0 (iii) ∞ (iv) None of these
2. If $f(z)$ is analytic and non-constant in a region Ω , then which value of $f(z)$ has no maximum in Ω? **(K4-An, CO-2)**
3. If $f(z)$ is analytic in a region Ω, then for which type of cycle $\int_\gamma f(z)dz = 0$. **(K3-Ap, CO-3)**
4. True or False: Taylor's Series is valid in throughout the complex plane. **(K3-Ap, CO-4)**
5. Write the two standard representation of rational function. **(K4-An, CO-5)**

Part B (6 marks)

1. (i). If γ lies inside a circle, then prove that $n(\gamma, a) = 0$ for all points a outside the circle
   (ii). If a is a point inside the circle C, then prove that $n(\gamma, a) = 1$. **(K2-U, CO-1)**
2. Verify the Statement. A function which is analytic and bounded in the whole plan must reduce to a constant. **(K4-An, CO-2)**
3. Evaluate $\int_0^{2\pi} \frac{1}{a+cos\theta} d\theta, a > 1$. **(K5-E, CO-3)**
4. 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. **(K3-Ap, CO-4)**
5. Show that $sin\pi z$ is an entire function of genus 1. **(K4-An, CO-5)**

Part C (12 marks)

1. Let $f(z)$ be analytic in an open disk Δ and γ be a closed curve in Δ. Then prove that 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. **(K3-Ap, CO-1)**
2. Show that 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. **(K4-An, CO-2)**
3. Evaluate $\int_0^\pi \log sinx\ dx$. **(K5-E, CO-3)**
4. 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.

$$f(z) = f(z_0) + \frac{f'(z_0)}{1!}(z-z_0) + \cdots + \frac{f^n(z_0)}{n!}(z-z_0)^n + \cdots$$ **(K3-Ap, CO-4)**

5. 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 prove that $\log|f(0)| = -\sum_{k=1}^n \log\left(\frac{\rho}{|a_k|}\right) + \frac{1}{2\pi}\int_0^{2\pi} \log|f(\rho e^{i\theta})|\, d\theta$. **(K4-An, CO-5)**

Head of the Department **Course Instructor**

[Dr. M. K. Angel Jebitha] **[Dr. A. Anat Jaslin Jini]**

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:	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	K1
CO - 2	defends the basic results in topological spaces, continuous functions, connectedness, compactness, countability and separation axioms and complete metric spaces	K2
CO - 3	solve problems on topological spaces, continuous functions and topological properties	K3
CO - 4	analyse various facts related to continuous functions, connected spaces, compact spaces, countable spaces, separable spaces, normal space and compact spaces	K4
CO - 5	evaluate the comparison between different types of topological spaces	K5

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

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

Unit	Module	Topic	Teaching Hours	Assessment Hours	Cognitive level	Pedagogy	Student Centric Method	E-Resources	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	1	K2	Collaborative learning	Participative Learning	YouTube Videos	Short summary, MCQ, Oral Questions, CIA I
	2.	Order topology: Definition & Examples, Product topology on XxY: Definition & Theorem	4	1	K3	Lecture	Participative Learning: Group Discussion	Presentation , E-notes, Video materials	Recalling, Quiz, Concept test, CIA I
	3.	The Subspace Topology: Definition & Examples, Theorems	4	1	K2	Lecture with Illustrations		Power Point Presentation , E-notes, Video materials	Slip Test, Questioning, CIA I

	4.	Closed sets: Definition & Examples, Theorems, Limit points: Definition Examples & Theorems , Hausdorff Spaces: Definition & Theorems	4		K1, K2	Inductive Method,	Brainstorming, Group Discussion	Power Point Presentation , E-notes, Video materials	Concept mapping, Concept explanation, CIA I
	5.	Continuity of a function: Definition, Examples, Theorems, Homeomorphism: Definition & Examples, Rules for constructing continuous function, Pasting lemma & Examples, Maps into products	4	1	K1	Heuristic Method, Illustrative method, Analytic Method, Inductive Method	Concept Mapping, Brainstorming	YouTube Videos	MCQ, Oral Questions, CIA I
II	**THE PRODUCT TOPOLOGY, THE METRIC TOPOLOGY & CONNECTED SPACES**								
	1.	The Product Topology: Definitions, Comparison of box	3	1	K4	Flipped Classroom, Collaborative learning,	Inquiry Based Learning, Concept	YouTube Videos	Slip Test , Group quiz, Assignment, CIA I

		and product topologies, Theorems related to product topologies, Continuous functions and examples				Inquiry-Based Learning,	Mapping, Brainstorming		
	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	1	K2, K3	Analytic Method, Collaborative learning, Inquiry-Based Learning, Illustrative method	Brainstorming, Group Discussion	Power Point Presentation , E-notes, Video Materials	Think-Pair-Share, CIA I
	3.	Connected Spaces: Definitions, Examples, Lemmas and Theorems	3		K1, K3	Collaborative learning, Inquiry-Based Learning, Illustrative method, Flipped Classroom	Participative Learning: Visual exploration, Group quiz	Power Point Presentation , E-notes, Video Materials	Recalling Steps, Concept mapping, CIA I

	4.	Components and Local Connectedness: Definitions, Path components, Locally connected, Locally path connected: Definitions and Theorems	4	1	K3, K4	Lecture with discussion, Deductive Method, Group Discussion	Think-Pair-Share, Brainstorming, Group Discussion	YouTube Videos	MCQ, Oral Questions, CIA I
	5.	The Product Topology: Definitions, Comparison of box and product topologies, Theorems related to product topologies, Continuous functions and examples	4	1	K3, K4	Inquiry-Based Approach, Flipped Classroom	Participative Learning, Concept Mapping, Brainstorming	YouTube Videos	Oral presentation, CIA I
III	**COMPACTNESS**								
	1.	Compact space: Definition, Examples, Lemma, Theorems and Image of a	4	1	K1 & K2	Contextual Based Learning, Deductive Method	Inquiry Based Learning Concept Mapping, Brainstorming	Power Point Presentation, E-notes, Video Materials	Quiz, CIA I

		compact space, Product of finitely many compact spaces, Tube lemma, Finite intersection property: Definition & Theorem							
	2.	Compact Subspaces of the Real Line: Theorem, Characterize compact subspaces of R^n, Extreme value theorem, The Lebesgue number lemma, Uniform continuity theorem	4	1	K3 & K4	Brainstorming, Group Discussion, Flipped Classroom	Participative Learning, Concept Mapping, Brainstorming	Power Point Presentation, E-notes, Video Materials	Think-Pair-Share, CIA II
	3.	Limit Point Compactness: Definitions, Examples and Theorems, Sequentially compact	3	1	K1 & K3	Blended Learning, Collaborative learning, Inquiry-Based Learning	Concept Mapping, Peer Teaching	YouTube Videos	Home assignment, Worksheets, Assignment, CIA II
	4.	Local compactness:	3		K1 & K2	Collaborative learning,	Participative Learning,	YouTube Videos	Collaborative worksheet,

		Definition & Examples, Theorems				Brainstorming, Group Discussion	Concept Mapping, Brainstorming		Peer-assessed worksheet, CIA II
IV	**SEPARATION AXIOMS**								
	1.	First Countability axiom, Second Countability axiom: Definitions, Theorems, Dense subset: Definitions & Theorem, Examples, Lindelof space : Definition, Examples	3	1	K3	Lecture with Illustration Problem-solving, Analytic Method, Inductive Method	Participative Learning, Concept Mapping	Power Point Presentation, E-notes, Video Materials	Seminar, CIA II
	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	3		K3	Lecture method, Deductive Method, Group Discussion	Inquiry Based Learning, Concept Mapping, Brainstorming	Power Point Presentation, E-notes, Video Materials	Concept Explanation, CIA II

	3.	Normal Spaces: Theorems and Examples	3	1	K1 & K2	Collaborative Learning, Flipped Classroom	Participative Learning, Concept Mapping, Brainstorming	Power Point Presentation, E-notes, Video Materials	Slip Test , Concept explanations, Oral presentation, CIA II
	4.	Urysohn lemma	2		K2	Lecture method, Heuristic Method, Brainstorming	Inquiry Based Learning, Concept Mapping, Brainstorming	Power Point Presentation, E-notes, Video Materials	Oral presentation, Questioning, CIA II
V	**URYSOHN METRIZATIONTHEOREM, TIETZE EXTENSION THEOREM & COMPLETE METRIC SPACE**								
	1.	Urysohn metrization theorem, Imbedding theorem	3	1	K2	Inquiry-Based Learning, Illustrative method, Flipped Classroom	Inquiry Based Learning, Concept Mapping, Brainstorming	Power Point Presentation, E-notes, Video Materials	Oral presentation, Short test, CIA II
	2.	Tietze extension theorem	3		K2	Collaborative learning, Inquiry-Based Learning,	Participative Learning, Concept Mapping, Brainstorming	Power Point Presentation, E-notes, Video Materials	Concept explanations, Oral presentation, CIA II
	3.	Complete Metric Spaces: Definitions, Examples and Theorems, Isometric embedding	3	1	K3 & K4	Lecture method, Heuristic Method, Deductive Method	Participative Learning, Group discussion, Brainstorming	Power Point Presentation, E-notes, Video Materials	Seminar, Concept explanations, CIA II

	4.	Compactness in Metric spaces: Totally bounded, Pointwise bounded, Equicontinuous, Definitions, Lemmas, Theorems	3		K3 & K4	Collaborative learning, Brainstorming, Group Discussion	Inquiry Based Learning, Concept Mapping, Brainstorming	Power Point Presentation, E-notes, Video Materials	Quiz, CIA II

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): -
Activities related to Cross Cutting Issues: -
Assignment: **Prove given results (Exercise problems in the text book)** (Last date for Submission : 25.08.2025)
Seminar Topic: **Closed Sets, Limit Points, Continuity of a Functions, Connected Space and Dense Sets**

Sample questions
Part A (1 Mark)

1. Which pair of topologies are not comparable? **(K4-An, CO-4)**
   (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 **(K3-Ap, CO-3)**
   (i) At least one f_α is continuous
   (ii) At most one f_α is continuous
   (ii) Each f_α is continuous
   (iv) None of the above

3. Under which mapping the image of compact space is compact **(K4-An, CO-4)**
   (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 _____. **(K2-U, CO-4)**
5. Say True or False: The Tietze extension theorem implies the Uryshon lemma. **(K1-R, CO-1)**

Part B (6 Marks)

1. Define order topology and give two examples for the same. **(K2-U, CO-4)**
2. Let X be a metric space with metric d. Then prove that $\bar{d}: X \times X \to \mathbb{R}$ by $\bar{d}(x,y) = \min\{d(x,y), 1\}$ is a metric that induces the same topology as d. **(K3-Ap, CO-3)**
3. Show that compactness implies limit point compactness. **(K4-An, CO-4)**
4. Prove that every metrizable space is normal. **(K2-U, CO-4)**
5. A metric space is complete iff every Cauchy's sequences has a convergent subsequences. **(K4-An, CO-4)**

Part C (12 Marks)

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. **(K3-Ap, CO-3)**
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 $\mathbb{R}^n$. **(K2-U, CO-4)**
3. State and prove the Lebesgue number lemma. **(K2-U, CO-4)**
4. Prove that a subspace of a Hausdorff space is Hausdorff and a product of Hausdorff spaces is Hausdorff. **(K3-Ap, CO-3)**
5. State and prove Urysohn meterisation theorem. **(K2-U, CO-4)**

Head of the Department
Dr. M. K. Angel Jebitha

Course Instructor
Dr.J.Befija Minnie

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	S	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

COs	Upon completion of this course, the students will be able to:	Cognitive Level
CO - 1	grasp concepts like time dilation, relativistic dynamics, and the equivalence principle.	K_4, K_5
CO - 2	understand classical mechanics principles, such as coordinates, constraints, and energy-momentum relationships, to analyse mechanical systems.	K_1, K_2
CO - 3	apply Lagrangian methods to special cases such as impulsive motion and systems with constraints, thereby expanding their problem-solving abilities.	K_3
CO - 4	Integrate classical and relativistic mechanics, enabling them to analyze systems ranging from everyday mechanics to those involving high speeds and gravitational forces.	K_3, K_5
CO - 5	become proficient in using Lagrangian mechanics to solve complex problems and identify integral properties of motion.	K_2, K_3

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

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

Unit	Module	Topic	Teaching Hours	Cognitive level	Pedagogy	Student-Centric Method	E-Resources	Assessment/ Evaluation Methods
I	**THE MECHANICAL SYSTEM**							
	1	The Mechanical System	3	K1(R), K2 (U)	Recall the basic definitions, Discussions	Discussions, Brainstorming	E-Note	Questioning
	2	Generalized coordinates, Constraints	4	K4(An), K5(E)	Transmissive method with illustration, Team work	Think -Pair-Share, Discussions	PPT, YouTube-Types of constraints	Summarize the concepts
	3	Virtual work and D'Alembert's Principle	4	K2(U), K5(E)	Illustrative Method, Team work	Defining problems, Group discussion	E-Note	Questioning
	4	Energy and Momentum	4	K2(U), K5(E)	Transmissive method	Discussions, Debates	E-Book, You Tube-Generalized Momentum	Assignment
II	**LAGRANGE'S EQUATIONS**							
	1	Derivation of Lagrange's equations	5	K1(R)	Brainstorming	Problem solving, Think -Pair- Share	PPT	Slip Test
	2	Problems using Lagrange's equation	5	K2(U)	Transmissive method, Discussion	Discussions, Debates	E-Note, You tube-Examples of LE	Collecting MCQ

	3	Integralsof the motion.	5	K2(U)	Think-Pair-Share, Flipped Classroom	Discussions, Brainstorming,	E-Note	Quiz
III	**SPECIAL APPLICATIONS OF LAGRANGE'S EQUATIONS**							
	1	Special Applications of Lagrange's Equations, Rayleigh's Dissipation Function	4	K2(U)	Transmissive method, Group Discussion	Problem solving, Think -Pair- Share	E-Book, YouTube	Slip Test
	2	Impulsive Motion, Impulsive, and Momentum	3	K3(Ap), K4(An)	Illustrative Method, Team Work	Discussions, Debates	E-Note	Questioning
	3	Lagrangian method, Ordinary constraints, Impulsive constraints	4	K3(Ap), K4(An)	Problem Solving, Team work	Defining problems, Group discussion,	E-Note, You tube- Impulsive constraints	Collecting MCQ
	4	Energy considerations- Quasi–coordinates. Examples	4	K2(U), K5(E)	Transmissive method	Problem solving, Think -Pair- Share	E-Book	CIA-I, Quiz
IV	**INTRODUCTION TO RELATIVITY**							
	1	Introduction to Relativity, Introduction, Galilean transformation	2	K1(R), K2(U)	Illustrative Method, Team work	Group Discussions, Think -Pair- Share	E-Book, PPT	Slip Test
	2	Maxwell's equations, The ether theory, The principle of relativity, Relativistic Kinematics	3	K3(Ap)	Illustrative Method, Group Discussion	Defining problems, Group discussion	E-Book, PPT	MCQ

	3	The Lorentz transformation equations, Events and simultaneity, Einstein's train, Time dilation	4	K2(U)	Illustrative Method	Defining problems, Group discussion	E-Book, PPT	Quiz, Collecting MCQ
	4	Longitudinal contraction, the invariant interval, proper time, and proper distance	3	K3(Ap), K4(An)	Transmissive Method, Team work	Presentation, Think-Pair-Share	E-Book, PPT	Questioning
	5	The world line, the twin paradox, the Addition of velocities, the relativistic Doppler effect	3	K2(U), K4(An)	Transmissive Method, Discussion	Real -world problems, Discussions	E-Book, PPT, You tube-The relativistic Doppler effect	Slip Test
V	**RELATIVISTIC DYNAMICS**							
	1	Relativistic Dynamics, Momentum, Energy	4	K2(U)	Transmissive Method, Presentation	Defining problems, Group discussion	E-Book, PPT	Questioning
	2	The momentum, energy four vector, Force, Conservation of energy, Mass and energy, inelastic collision	4	K3(Ap), K4(An)	Illustrative Method,	Presentation, Think-Pair-Share	E-Book, PPT	MCQ, Quiz
	3	The principle of equivalence, Lagrangian and	4	K2(U), K3(Ap)		Real -world problems, Group Discussion	E-Book, PPT, You tube-	CIA- II, Quiz

		Hamiltonian formulations, Accelerated systems			Illustrative Method, Presentation		Accelerated systems	
	4	Rocket with constant acceleration, Rocket with constant thrust	3	K2(U)	Transmissive Method, Presentation, Think-Pair-Share	Peer Instruction, Group Discussions	E-Book, PPT	Questioning, Slip Test

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

Activities (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 Mark)

1. The types of constraints are ----------
2. The generalized coordinates are ---------

3. The derivation of Lagrange's equations for a holonomic system required that the generalized coordinates be ----------

a) Dependent b) independent c) derivable d) both(a), (c)

4. The change in the total linear momentum of a system during a given time interval is equal to the total impulse of the external forces acting over the same interval.
a) True b) False

5. The equivalence of mass and energy also applies to particles such as photons which have a - - - - - - - - - - - - rest mass.

a) unity b) zero c) empty d) reversal force

Part B (6 Marks)

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 is 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.

3. Explain workless constraints with examples.

4. Derive the Lagrange's equation for non-holonomic constraints.

5. Derive the relative Doppler effect.

Part C (12 Marks)

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

$x(t_1) = 1m \qquad y(t_1) = 1m \qquad \theta(t_1) = \frac{\pi}{4}$; $\qquad \dot{x}(t_1-) = 0 \qquad \dot{y}(t_1-) = 1m/\sec \qquad \dot{\theta}(t_1-) = 1rad/\sec$

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

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

3. Derive the equation of motion for small oscillation.
4. A double pendulum consists of two particles suspended by massless rods. Find the differential equations of motion assuming that all motion takes place in a vertical plane. Linearize these equations, assuming small motions.

5. Derive Maxwell's Equation.

Head of the Department

Dr. M. K Angel Jebitha

Course Instructor

Mrs. J C Mahizha

Department : Mathematics
Class : II M. Sc Mathematics
Title of the Course : ELECTIVE COURSE V: INTRODUCTION TO MACHINE LEARNING USING PYTHON
Semester : III
Course Code : MP233EC2

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP233EC2	4	-	-	-	3	4	60	25	75	100

Learning Objectives:

1. To learn machine learning and the usage of Python for data analysis.
2. To explore probability theory and data visualization techniques using Python.

Course Outcomes

CO	On the successful completion of the course, students will be able to:	Cognitive level
CO1	gain a solid understanding of probability theory, including random experiments and the binomial distribution.	**K1, K2**
CO2	understand the importance of machine learning and its application in analytics	**K2**
CO3	declare variables, use conditional statements, generate sequence numbers, implement control flow statements, and define functions.	**K3**

4	acquire knowledge of statistical concepts such as the normal distribution, and other important probability distributions, enabling them to analyze data effectively using Python	**K4**
5	possess skills in data exploration and visualization, capable of drawing various plots including bar charts and comparing distributions.	**K5**

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

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

Unit	Module	Topic	Teaching Hours	Assessment Hours	Cognitive level	Pedagogy	Student Centric Method	E-Resources	Assessment/ Evaluation Methods
I	**INTRODUCTION TO MACHINE LEARNING**								
	1	Introduction to Analytics and Machine Learning	3	1	K1(R)	Lecture Method Interactive Method Socratic Method	Think-Pair-Share, Inquiry-Based Learning	. E-material Interactive PPT Video Lectures LMS	Oral Quiz Exit Ticket One-Sentence Summary Concept Questions, CIA I
	2	Why Machine Learning ?	1		K3(Ap)	Inquiry-Based Learning Interactive Method	Think-Aloud Visual Diagrams Quick Fire Questions	E-material Interactive PPT Video Lectures	Conceptual Quiz, Group Presentation, CIA I

	3	Framework for Developing Machine Learning Models	2	1	K1(R)	Analytical Method Illustrative Method	Collaborative Learning, Concept Mapping	-	Concept Explanation MCQ CIA I.
	4	Why Python?	1		K2(U)	Computational Thinking Collaborative Learning	Think-Aloud Inquiry-Based Learning Peer Teaching	Video Lecture, Interactive Notes	Class Test Homework CIA I.
	5	Python Stack for Data Science	2	1	K5(E)	Problem-Based Learning Heuristic Method Collaborative Learning Algorithmic Approach	Lateral Thinking Break Down Problems Peer Discussion Error Analysis Real-World Applications	Online Tutorials and Notes:	Problem-Solving Assignments, Open Book Exam Questions, CIA I
II	**INTRODUCTION TO PYTHON**								
	1	Declaring Variables	1	1	K1(R)	Blended Learning	Peer Instruction, Blended Learning,	YouTube Lectures, Interactive PPT	Concept Relay Exit Ticket Quizizz Game CIA I
	2	Conditional Statements	2		K1(R)	Inquiry-Based Collaborative Learning	Peer Discussion Questions	Video Lectures LMS Google class room	Surprise Test CIA I

	3	Generating Sequence Numbers	1	1	K2(U)	Lecture with Illustration Interactive Method	Peer Teaching	Interactive PPT LMS	Assignments, Questions, CIA I
	4	Control Flow Statements	2		K2(U)	Inquiry-Based Collaborative Learning	Peer Teaching	Interactive PPT Slido	Slip Test Homework CIA I
	5	Functions	3		K3(Ap)	Based Learning Algorithmic Approach	Jigsaw Method Peer Discussion	E-material Interactive PPT Google Class Room	Slip Test Homework Surprise Test CIA I
III	**EXPLORATION OF DATA USING VISUALIZATION**								
	1	Drawing Plots	1	1	K1(R)	Mathematical Derivations, Concept Mapping	Flipped Classroom, Peer Teaching	Video Lectures	Assessment, Conceptual MCQs One-minute paper CIA I
	2	Bar Chart Histogram	2		K2(U)	Application-Based Teaching	Socratic Questioning Peer Discussion	Video Lectures LMS Google class room	Concept Relay Exit Ticket Quizizz Game CIA I
	3	Distribution or Density Plot	2	1	K3(Ap)	Concept Building, Mathematical Insights	Peer Instruction	Interactive PPT LMS	Surprise Test CIA I

	4	Box Plot	2		K3(Ap)	Lecture with Illustration Interactive Method	Peer Discussion Questions	Interactive PPT Slido	Assignments, Questions, CIA I
	5	Comparing Distributions.	2	1	K4(An)	Blended Learning	Jigsaw Method Peer Teaching	E-material Interactive PPT Google Class Room	Slip Test Homework CIA I
IV	**PROBABILITY THEORY**								
	1	Introduction	1	1	K5 (E)	Inquiry-Based Learning	Think-Pair-Share, Inquiry-Based Learning	YouTube Lectures, Interactive PPT	Assignment, CIA II
	2	Random Experiment	2			Lecture with Illustration Interactive Method Blended Learning	Think-Aloud Visual Diagrams Quick Fire Questions	Video Lectures LMS Google class room	Visualization Task, Conceptual Quiz, Group Presentation, CIA II
	3	Sample Space Event	2		K5(E)	Inquiry-Based Learning	Collaborative Learning, Visual Diagrams	Interactive PPT LMS	Concept Explanation MCQ CIA II.
	4	Random Variables	2	1	K5(E)	Interactive Method Blended Learning	Think-Aloud Inquiry-Based Learning	Interactive PPT Slido	Class Test Homework CIA II

	5	Binomial Distribution	2	1	K5(E)	Application-Oriented Learning, Visual / Graphical Pedagogy	Lateral Thinking Break Down Problems	E-material Interactive PPT Google Class Room	Problem-Solving Assignments, Open Book Exam Questions, CIA II
V	**NORMAL DISTRIBUTION**								
	1	Example of Normal Distribution	2	1	K3(Ap)	Core Conceptual Approach	Think-Aloud Visual Diagrams Quick Fire Questions	.E-material Interactive PPT Video Lectures LMS	Oral Quiz Questions CIA I
	2	Mean and Variance	1	1	K3(Ap)	Visual Pedagogy	Think-Aloud Inquiry-Based Learning Peer Teaching	E-material Interactive PPT Video Lectures	Quiz CIA II
	3	Confidence Interval	2		K5(E)	Integrated Interdisciplinary Learning	Flipped Class room Visual Diagrams Questions	PowerPoint with graphical representations	Concept Explanation MCQ CIA II
	4	Cumulative Probability Distribution	2	1	K4(An)	Problem-Based Learning	Collaborative Learning, Visual Diagrams	Video Lecture, E-Notes	Class Test Homework CIA II
	5	Other Important Distributions	2		K2(U)	Interactive Method	Peer Instruction,	Online Tutorials and E-Notes:	Assignments, Open Book CIA II

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

Activities (Em / En /SD): **Hands on Training on Graphical Representation**

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

Environment Sustainability activities related to Cross Cutting Issues:-

Assignment: **Preparing Notes for Introduction to Python** (Last date to submit : 01-08-2025)

Seminar : **Exploration of Data Using Visualization**

Sample questions

Part A (1 mark)

1. Which of the following is the first step in developing a machine learning model? (CO2, K2)
   (a) Data entry (b) Data Collection (c) Data modification (d) Data Analysis
2. Which of the following is the correct way to define a function in Python? (CO3, K3)
   (a) def myFunc(): (b) def Func(): (c) myFunc(): (d) Func():
3. What does the height of a bar in a bar chart indicate? (CO5, K1)
4. Which distribution is suitable for binary outcomes in trials? (CO1, K2)
5. What does the area under the normal curve represent? (CO4, K4)

Part B (6 marks)

1. Discuss the steps in developing a Machine Learning model. (CO2, K2)
2. Write Python code to generate a sequence of numbers using range() and explain its output. (CO3, K3)

3. Explain how bar charts and histograms differ, with examples. (CO5, K4)
4. Explain the concept of binomial distribution with a real-life example. (CO1, K2)
5. Describe the properties of the normal distribution. (CO4, K4)

Part C (12 marks)

1. Describe in detail the steps involved in developing a Machine Learning model using Python. (CO2, K2)
2. Write a Python program using control flow statements and functions to display the Fibonacci sequence. Explain the logic used. (CO3, K3)
3. Illustrate and explain five different data visualization techniques using Python. (CO5, K4)
4. Explain binomial distribution in detail. Derive its formula and solve two numerical problems. (CO1, K2)
5. Describe normal distribution and explain how to compute confidence intervals using Z-scores with examples. (CO4, K4)

Head of the Department
Dr. M. K. Angel Jebitha

Course Instructor
Dr. M. K. Angel Jebitha

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

CO	On the successful completion of the course, students will be able to:	Cognitive level
CO1	understand the objectives and methods of research, standard structure of a scientific paper and avoid plagiarism.	**K2**
CO2	analyzing research data and statistical measures such as measures of central tendency, dispersion, and asymmetry.	**K4**
CO3	identify the ethics of scientific paper writing and analyze research problems	**K4**
CO4	develop research designs for specific research problems and assess the significance of research in various fields.	**K5**
CO5	create structured scientific research papers and write project proposals and progress reports for research funding.	**K6**

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

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

Unit	Module	Topic	Teaching Hours	Assignment Hours	Cognitive level	Pedagogy	Student Centric Method	E-Resources	Assessment/ Evaluation Methods
I	**RESEARCH METHODOLOGY**								
	1.	Research Methodology: An Introduction, Meaning of Research, Objectives of Research -	1	1	K2	Brainstorming	Think Pair Share	Interactive PPT	Conceptual Quiz, Group Presentation, CIA I
	2.	Motivation in Research - Types of Research	1		K2	Lecture	Group Discussion	Online Tutorials and Notes	Slip Test, CIA I
	3.	Research Approaches - Significance of Research	1	1	K2	Analytic Method	Concept Mapping	PowerPoint Presentation	Questioning, CIA I
	4.	Research Methods versus Methodology - Research and Scientific Method - -	1		K4	Heuristic Method	Concept based discussion	YouTube Video	Concept explanations, CIA I

	5.	Importance of Knowing How Research is Done-research Process	1	1	K2	Collaborative learning	Collaborative learning	Online Tutorials and Notes	Written Assignment, Open Book Exam Questions, CIA I
	6.	Criteria of Good Research - Problems Encountered by researchers in India	1		K6	Blended classroom	Write and discuss	YouTube Video	Recall Steps, CIA I
II	**DEFINING THE RESEARCH PROBLEM**								
	1.	Selecting the Problem, Necessity of Defining the Problem	1	1	K4	Participative	Step by step learning	YouTube Video	Peer Review, CIA I
	2.	Technique Involved in Defining a Problem - An Illustration	1		K2	Lecture Method	Think Aloud Session	Interactive PPT	Slip Test, CIA I
	3.	Research Design - Meaning of Research Design	1	1	K4	Problem Solving	Inductive Method	Online Tutorials and Notes	Short summary of the concept, CIA I
	4.	Need for Research Design - Research Methodology	1		K4	Inductive Method	Concept based discussion	YouTube Video	Written Assignment, Oral Presentation, CIA I

	5.	Features of a Good Design - Important Concepts Relating to Research Design	1	1	K4	Analytic Method	Collaborative learning	PowerPoint Presentation	Conceptual Quiz, Group Presentation, CIA I
	6.	Different Research Designs Basic Principles of Experimental Designs, Developing Research Plan.	1		K4, K5	Collaborative learning	Concept based discussion	Online Tutorials and Notes	Recall steps, CIA I
III	**PROCESSING AND ANALYSIS OF DATA**								
	1.	Processing Operations	1	1	K2	Inductive Method	Mind map	YouTube Video	Quiz, CIA I
	2.	Some Problems in Processing	1		K4, K5	Lecture	Think Pair Share	Online Tutorials and Notes	Recall steps, CIA I
	3.	Elements / Types of Analysis	1		K2	Lecture with illustration	Peer Tuturing	Interactive PPT	Slip Test, CIA I
	4.	Statistics in Research	1	1	K2	Lecture Method	Group Discussion	Power Point Presentation	Peer discussion, CIA II
	5.	Measures of Central Tendency	1		K2	Collaborative learning	Jigsaw method	YouTube Video	Concept check, CIA II
	6.	Measures of Dispersion, Measures of	1	1	K2	Flipped Classroom	Concept based discussion	Online Tutorials and Notes	MCQ, CIA II

		Asymmetry (Skewness)							
IV	**RESEARCH PROJECT**								
	1.	Difference between a Dissertation and a Thesis	1	1	K2	Brainstorming	Group reflection	Online Tutorials and Notes	Slip Test, CIA II
	2.	Basic Requirements of a Research Degree – Deciding on a research topic	2		K4	Flipped Classroom	Inquiry Based Learning	YouTube Video	Quiz, CIA II
	3.	Writing a proposal – Familiarity with Codes of Practice/ Rules and Regulations	1	1	K5	Integrative method	Heuristic Method	PowerPoint Presentation	Written Assignment, Oral Presentation, CIA II
	4.	Ethical considerations - Different components of a Research Project	1		K4, K5	Collaborative learning	Brain storming	YouTube Video	Simple Questions, CIA II
	5.	Title page – Abstract – Acknowledgement	1	1	K5	Analytic Method	Problem Based Learning	Online Tutorials and Notes	Concept Explanation, CIA II
	6.	List of Contents, Literature Review, Methodology	1		K2	Heuristic Method	Concept Mapping	Online Tutorials and Notes	Sip test, CIA II

V	**PUBLISHING AND PRESENTING YOUR RESEARCH AND TOOL KIT**								
	1.	Journal Articles	1	1	K2	Lecture with illustrations	Student Expert Talk	Interactive PPT	Written Assignment, Oral Presentation, CIA II
	2.	A book	2		K4	Socratic method	Peer Teaching	Interactive PPT	Peer Assessment, CIA II
	3.	Conference Presentation	1	1	K2	Collaborative learning	Collaborative Learning	Interactive PPT	Slip Test, CIA II
	4.	A final note	1		K4	**Lecturing, Inquiry-based Learning**	Learning Circle Presentation	Interactive PPT	Written Assignment, Open Book Exam Questions, CIA II
	5.	All punctuations	1	1	K4	Blended classroom	Topic Exploration and Sharing	Interactive PPT	Open Book Test, CIA II

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

Activities (SD): **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 unit V)** (last date to submit: 30-09-2025)

Seminar Topic: **Publishing and Presenting your Research and Tool kit**

SAMPLE QUESTIONS

Part A (2 Marks)

1. What is the primary purpose of research? (CO1, K2)

   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. (CO1, K2)
3. Common measures include mean, median, and mode. (State True / False) (CO2, K4)
4. ---------- provides a concise summary of the research project, including its purpose, methods, results, and conclusions. (CO1, K2)
5. What challenges might researchers encounter during the publication process? (CO3, K4)

   a. manuscript rejection b. lengthy peer review processes

   c. difficulty finding suitable journals for publication d. All the above

Part B (4 Marks)

1. Identify and analyse the common problems encountered by researchers in India. (CO3, K4)
2. Describe the necessity of research design in a research study. (CO4, K2)
3. Elaborate on the different types of analysis commonly used in research. (CO2, K4)
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. (CO4, K5)
5. Explain the role of toolkits in research project management. How can researchers customize toolkits to suit their specific research needs? (CO5, K6)

Part C (12 Marks)

1. Compare and contrast quantitative and qualitative research methods, highlighting their respective strengths and weaknesses. Provide examples of research studies that employ each approach. (CO1, K4)
2. Explain the basic principles underlying experimental designs and their significance in experimental research. (CO4, K2)
3. Critically analyze the role of statistics in research, discussing its importance in drawing meaningful conclusions from data analysis. (CO2, K4)
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? (CO5, K5)
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? (CO5, K6)

Head of the Department
Dr. M.K. Angel Jebitha

Course Instructor
Dr. K. Jeya Daisy