Syllabus template

Semester: 5	
Programme : Mathematics	
Course : Algebra-1 & Analysis-1	
Paper code: B3MT230511T	Credits: 4
Hours/week : 4 hours	
Category: Core/MDC/SEC/VAC : Minor	
Theory / Practical / Composite : Theory	
No of Modules : Nil	

Course Overview: Algebra-1 & Analysis-1

This course introduces the fundamental concepts in Algebra and Mathematical Analysis, providing the essential theoretical background and problem-solving skills required for advanced mathematical study. The Algebra–I component focuses on the structure of complex numbers, properties of polynomials, and fundamental concepts of set theory, relations, and mappings. The Analysis–I component builds an understanding of the real number system, sequences and series of real numbers and limits, emphasizing logical reasoning and rigorous proof-based learning.

Course Outcome: **Algebra-1 & Analysis-1**

1. Understand and apply different representations of complex numbers, including modulus–amplitude and exponential forms, and use De Moivre's theorem and Euler's formula to solve related problems.
2. Analyze algebraic equations using the Fundamental Theorem of Algebra, Descartes' Rule of Signs, and Bolzano's theorem, and evaluate relations between roots and coefficients of polynomials.
3. Apply classical algebraic methods such as Cardan's and Ferrari's techniques to solve cubic and biquadratic equations, demonstrating proficiency in symbolic manipulation.
4. Explain and interpret the concepts of sets, relations, and equivalence relations, and demonstrate understanding of partitions and Cartesian products in formal mathematical reasoning.
5. Distinguish between injective, surjective, and bijective mappings, and construct and verify compositions and inverses of mappings in mathematical contexts and applying them in various mathematical problems.
6. Describe and justify the properties of the real number system, including boundedness, completeness, density property of real numbers and analyze the Archimedean property forming the foundations of real analysis.
7. Determine the convergence of sequences of real numbers using limit theorems, the Monotone Convergence Theorem, and Cauchy's Criterion, and apply these results in defining mathematical constants such as *e*.
8. Identify and test the convergence or divergence of series of real numbers using various standard tests (Comparison, Ratio, Root, Raabe's, Leibnitz), and apply them in various problems.
9. Analyze and use the ε–δ definition and Cauchy's definition of the limit of a real-valued function, and verify limit properties using sequential criteria and algebraic operations.

Prerequisites: *Basic knowledge about any prior course: plus 2 level Calculus*

SYLLABUS: Algebra-1 & Analysis-1

UNIT/Module	CONTENT	HOURS or NUMBER OF CLASSES	CO Mapping	COGNITIVE LEVEL

I.	Algebra-1:[32] ComplexNumbers[10] : Representation, Modulus-Amplitude form, Triangle inequality, De Moivre's theorem and its applications (6), Definition and problems on e^{ix} , $Log\ Z$, $SinZ$, $Cos\ Z$, a^z (4)	10 classes	CO1	K2, K3
II.	Polynomials [12]: Fundamental Theorem of Classical Algebra (statement only). Nature of roots of an equation (surd or complex roots occur in pairs) , Statement of Descartes' rule of signs and its applications(3). Statement of Bolzano's theorem on continuity in case of polynomials. Relation between roots and coefficients(3). Symmetric functions of roots(1). Transformations of equations (2). Cardan' s method of solving a cubic & Ferrari's method for a biquadratic equation(3).	12 classes	CO2, CO3	K3, K4, K5
III.	Set Theory & Binary Relations [6]: Cartesian product of sets, Relations on a set. Reflexive, symmetric and transitive properties of a relation on a set(3). Equivalence relations, equivalence class& partitions-illustrative discussions (3).	6 classes	CO4	K2, K3
IV.	Mappings [4]: Injective, surjective and bijective mappings. Composition of mappings, Invertibility of mappings (4)	4 classes	CO5	K2, K3, K4
V.	Analysis-1: [20] Real numbers [3]: Bounded sets of real numbers: theirsup. and inf.,Statement of Least upper bound axiom, Density of rationals and irrationals in real number system, Archimedean property[3]	3 classes	CO6	K2, K4
VI.	Sequence[7]: Definition , Bounded& unbounded sequence , Monotone sequence(2) Limit of a sequence & its uniqueness .statement of limit theorems(2). Statement of Monotone Convergence Theorem and its applications-definition of e (2) Statement of Cauchy's General Principle of convergence and its applications(1).	7 classes	CO7	K3, K4, K5
VII.	Series of real numbers [7]: Definition of Convergent and divergent series: examples. Cauchy's principle as applied to infinite series (application only).Necessary condition of convergence. Statement of	7 classes	CO8	K2, K5

	convergence of Geometric series and p-series (3). Statement of tests of convergence of series of positive terms: Comparison Test, Ratio Test, Cauchy's Root Test. Raabe 's test— applications (3). Alternating series: statement of Leibnitz Test and its applications(1).			
VIII.	Limit of Real valued functions[3]: limit of a function ($\varepsilon - \delta$ definition, and Cauchy's definition) criterion and Sequential criteria. Algebra of limits	3 classes	CO9	K4, K5, K6
Text Books				
1. Classical Algebra: S.K.Mapa				
2. Higher Algebra: Abstract and Linear: S.K.Mapa				
3. An Introduction to Analysis (Differential Calculus (Part-1)): Maity & Ghosh				
Suggested readings				
1. Introduction to Real Analysis: Bartle & Sherbert				
2. Calculus(Vol-1): T.M.Apostol				
3. Mathematical Analysis: Malik & Arora				
Web Resources				
1.				
2.				
3.				
4.				
Evaluation: End Sem; 70 CIA:30(20(MidSem)+5(Assignment) +5(Attendance))				
Paper Structure for Theory Semester Exam: 7 questions each carrying 10 marks out of 13/14 questions.				

Course outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive levels
CO1	Understand and apply different representations of complex numbers, including modulus–amplitude and exponential forms, and use De Moivre's theorem and Euler's formula to solve related problems.	K2, K3
CO2	Analyze algebraic equations using the Fundamental Theorem of Algebra, Descartes' Rule of Signs, and Bolzano's theorem, and evaluate relations between roots and coefficients of polynomials.	K4, K5
CO3	Apply classical algebraic methods such as Cardan's and Ferrari's techniques to solve cubic and biquadratic equations, demonstrating proficiency in symbolic manipulation.	K3
CO4	Explain and interpret the concepts of sets, relations, and equivalence relations, and demonstrate understanding of partitions and Cartesian products in formal mathematical reasoning.	K2, K3
CO5	Distinguish between injective, surjective, and bijective mappings, and construct and verify compositions and	K2, K3, K4

	inverses of mappings in mathematical contexts and applying them in various mathematical problems.	
CO6	Describe and justify the properties of the real number system, including boundedness, completeness, density property of real numbers and analyze the Archimedean property forming the foundations of real analysis.	K2, K4
CO7	Determine the convergence of sequences of real numbers using limit theorems, the Monotone Convergence Theorem, and Cauchy's Criterion, and apply these results in defining mathematical constants such as *e*.	K3, K4, K5
CO8	Identify and test the convergence or divergence of series of real numbers using various standard tests (Comparison, Ratio, Root, Raabe's, Leibnitz), and apply them in various problems.	K2, K5
CO9	Analyze and use the ε–δ definition and Cauchy's definition of the limit of a real-valued function, and verify limit properties using sequential criteria and algebraic operations.	K4, K5, K6