

Syllabus template

Semester: I				
Programme: Mathematics				
Course: Calculus-1 and Vector Algebra & Matrix Algebra [Chem+Microbio+Biotech]				
Paper code: B1MT230111T				Credits: 4
Hours/week: 4				
Category: Core/MDC/SEC/VAC: Minor				
Theory / Practical / Composite: Theory				
No of Modules: Nil				
<p>Course Overview: This course provides a foundational understanding of Calculus, Vector Algebra, and Matrix Algebra, focusing on concepts essential for mathematical reasoning and problem solving. Students learn to analyse the behaviour of functions, apply differentiation and the mean value theorems, and approximate functions using series expansions. The course also develops geometric insight through vectors, enabling interpretation of lines, planes, and spatial configurations. Matrix algebra is introduced as a tool for representing linear systems and understanding conditions for solvability. By combining analytical techniques with geometric and algebraic representations, this course nurtures logical thinking and builds a strong base for higher mathematics.</p>				
Course Outcome:				
1. Determine whether a function is increasing or decreasing and interpret the rate of change to analyse variation in real-world quantities.				
2. Explain and apply the Mean Value Theorems to estimate bounds and intermediate values in practical contexts.				
3. Approximate unknown function values using Taylor's expansion and analyse the accuracy of such approximations.				
4. Represent periodic functions using Fourier series and interpret their behaviour through trigonometric components.				
5. Determine maxima and minima of functions of one variable and apply differential methods to solve optimisation problems.				
6. Test convergence or divergence of sequences and series using standard convergence tests.				
7. Use vector algebra to study geometric properties of lines, planes and three-dimensional configurations.				
8. Apply matrix operations to represent linear transformations and evaluate determinants to determine matrix invertibility.				
9. Analyse the consistency of a system of linear equations and solve using elementary row operations.				
<p>Prerequisites: <i>Basic knowledge of Higher Secondary Mathematics including algebra, coordinate geometry, and elementary calculus (limits and derivatives).</i></p>				
SYLLABUS				
UNIT/Module	CONTENT	HOURS or NUMBER OF CLASSES	CO Mapping	COGNITIVE LEVEL
I. Infinite Sequence and	Module 1 [Calculus 1]: Bounded, monotone and	9 hours	CO6	K4

<p>Series</p>	<p>convergent sequence, Monotone Bounded sequences converge (statement only): applications [3]. Convergence and divergence of a series. Necessary condition of convergence, Geometric & p-series (statement only). Statement of tests of convergence of positive series: Comparison, D'Alembert, Cauchy, Raabe's Test: Applications [5]. Statement of Leibnitz's Test for convergence of alternating series [1].</p>			
<p>II. Differentiation and Mean Value Theorems</p>	<p>LHD & RHD: Examples, Sign of Derivative-monotone increasing and decreasing functions [4]. Mean Value Theorems: Rolle's, Lagrange's and Cauchy's theorems and their applications [without proof] [5]. Taylor's finite and infinite Series expansion, Application of the principle of maximum and minimum for a function of a single variable in geometrical, physical and other problems [4]. Fourier Series: statement of Dirichlet's Theorem: Examples [3].</p>	<p>16 hours</p>	<p>CO1, CO2, CO3, CO4, CO5</p>	<p>K2, K3, K4</p>
<p>III. Vector Algebra and its applications to Geometry</p>	<p>Module 2 [Vector Algebra & Matrix Algebra]: Basic Vector operations [2]. Multiplication of Vectors: Scalar and vector triple product [5]. Vector Equations of different forms of planes and straight lines, shortest distance between lines, volume of a tetrahedron [9].</p>	<p>16 hours</p>	<p>CO7</p>	<p>K3</p>
<p>IV. Matrices & Determinants</p>	<p>Unitary and Hermitian Matrices [3]. Laplace's expansion method for determinants [1]. Rank of a matrix by elementary row operations [4]. Consistency of a system of linear equations [3].</p>	<p>11 hours</p>	<p>CO8, CO9</p>	<p>K4</p>

Text Books
1. Introduction to Real Analysis: Bartle, Sherbert.
2. Real Analysis: S.K.Mapa.
3. Higher Algebra (Linear and Abstract): S.K.Mapa.
4. Vector Algebra: Maity, Ghosh.
5. Vector Algebra: Shanti Narayan and P.K. Mittal.
Suggested readings
1.
2.
3.
Web Resources
1. https://youtu.be/nH05UiErAX4
2. https://youtu.be/tffrztUhmw
3.
4.
Evaluation: Theory CIA: 20+5+5=30; Semester Exam: 70
Paper Structure for Theory Semester Exam Module: 7 questions each carrying 10 marks need to be answered out of 12/13 questions.

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive levels
CO1	Determine whether a function is increasing or decreasing and interpret the rate of change to analyse variation in real-world quantities.	K3
CO2	Explain and apply the Mean Value Theorems to estimate bounds and intermediate values in practical contexts.	K2, K3
CO3	Approximate unknown function values using Taylor's expansion and analyse the accuracy of such approximations.	
CO4	Represent periodic functions using Fourier series and interpret their behaviour through trigonometric components.	K2
CO5	Determine maxima and minima of functions of one variable and apply differential methods to solve optimisation problems.	K3, K4
CO6	Test convergence or divergence of sequences and series using standard convergence tests.	K4
CO7	Use vector algebra to study geometric properties of lines, planes and three-dimensional configurations.	K3
CO8	Apply matrix operations to represent linear transformations and evaluate determinants to determine matrix invertibility.	K3, K4
CO9	Analyse the consistency of a system of linear equations and solve using elementary row operations.	K4