Semester	**FOUR**
Course	**Major**
Paper Code	**C1ST230411T**
Paper Title	**Real Analysis II and Linear Algebra II**
No. of Credits	**4**
Theory / Practical /Composite	**Theory**
Classes per week	**Module I: 2 periods/week** **Module II: 2 periods/week**
Module	**2**

Course Outcomes for Module I

1. Remember the definitions of Riemann Integration, improper integrals, and the statements of Taylor's theorem and L'Hospital's rule.
2. **Understand** the properties of uniformly convergent functions, power series, and Beta and Gamma integrals**.**
3. **Apply** Taylor's theorem, L'Hospital's rule, and Riemann and double integrals to solve problems involving functions of one and two variables.
4. **Analyze** the convergence of series of functions using Weierstrass' M-test and examine the properties of pointwise and uniform convergence**.**
5. Evaluate the radius of convergence for power series and the maxima and minima of real-valued functions.
6. Create mathematical representations of functions in two variables using partial, total, and vector differentiation.

Course Outcomes for Module II

1. **Remember** the definitions of vector spaces, subspaces, basis, dimension, and characteristic roots,
2. **Understand** the properties of elementary matrices, the rank of matrix products, and the classification of quadratic forms,
3. **Apply** row reduction and echelon forms to find the solution sets of systems of linear equations ().
4. **Analyze** the relationship between row space, column space, and null space, including the standard theorems on matrix ranks.
5. **Evaluate** eigenvalues and eigenvectors using the properties of characteristic roots and the Cayley-Hamilton theorem.
6. **Create** canonical reductions of quadratic forms by determining their rank and signature.

Syllabus

Unit/Module	Content	No. of lectures	CO mapping	Cognitive levels
Module I				
	Applications of Differentiation: Taylor's theorem, remainder terms.			K1

Unit 1	Maxima and minima of functions. L'Hospital's rule of limits. Statements of results and applications. ***Reimann Integration***: Definition. Properties. ***Improper Integrals***: Definition, Simple tests. Beta and Gamma integrals- properties.	6 3 3	CO1 CO3 CO5 CO1 CO2 CO3 CO1 CO2	K3 K5 K1 K2 K3 K1 K2
Unit 2	***Sequences and Series of functions:*** Pointwise and uniform convergence. Properties of uniformly convergent functions. Weierstrass' M-test for convergence of series. Power series – radius of convergence, tests. Properties of power series. ***Analysis of functions in two variables:*** Partial and total differentiation. Vector differentiation. Double integrals.	7 7	CO2 CO4 CO5 CO3 CO6	K2 K4 K5 K3 K6
Module II				
Unit1	***Vector Space:*** Vector spaces, subspaces, sum of subspaces, span of a set, dimension and basis, ortho-complement space. Row space & column space of a matrix. Null space and nullity. Rank of a matrix, row-rank, column-rank, standard theorems on ranks, rank of the sum, and the product of two matrices.	12	CO1 CO4	K1 K4
Unit 2	***Solution of a system of linear equations:*** Elementary matrices, row reduction, and echelon forms, the matrix equations Ax=b, solution set of linear equations, application of linear equations.	5	CO2 CO3	K2 K3
Unit 3	***Eigen vectors and Eigen values:*** Characteristic roots and vectors,	5	CO1 CO5	K1 K5

	properties of characteristic roots, Cayley-Hamilton theorem.			
Unit 4	***Quadratic forms:*** Classification & canonical reduction. Rank and Signature.	4	CO2 CO6	K2 K6

Reading/Reference list

1. Bertle R. G., Sherbert D. R. (2011): Introduction to Real Analysis, 4th Edition, Wiley & Sons Inc.
2. Goldberg R. R. (2020): Methods of Real Analysis, Oxford & IBH Publishing Co Pvt Ltd.
3. Apostol T. M. (2007): Calculus Volume 1, 2nd Edition, John Wiley & Sons.
4. Apostol T. M. (2007): Calculus Volume 2, 2nd Edition, John Wiley & Sons.
5. Hadley G. (2002): Linear Algebra. Narosa Publishing House (Reprint).
6. Kenneth H. and Kunze R. (1978): Linear Algebra. Phi Learning Pvt Ltd.
7. Mapa S. K. (2016): Higher Algebra: Abstract and Linear. Levant Books.
8. Rao A. R. and Bhimasankaram P. (2000): Linear Algebra. Hindustan Book Agency.

Evaluation

	CIA: 30 Semester Exam: 70 Total: 100			
Paper Structure for Theory Semester Exam	Module-I (35 marks)		Module-II (35 marks)	
	5 marks Questions	15 marks Questions	5 marks Questions	15 marks Questions
	4 out of 6	1 out of 2	4 out of 6	1 out of 2

CO	CO Description for Module I	Cognitive levels
CO1	**Remember** the definitions of Riemann Integration, improper integrals, and the statements of Taylor's theorem and L'Hospital's rule.	K1
CO2	**Understand** the properties of uniformly convergent functions, power series, and Beta and Gamma integrals.	K2
CO3	**Apply** Taylor's theorem, L'Hospital's rule, and double integrals to solve problems involving functions of one and two variables.	K3
CO4	**Analyze** the convergence of series of functions using Weierstrass' M-test and examine the properties of pointwise and uniform convergence.	K4
CO5	**Evaluate** the radius of convergence for power series and the maxima and minima of real-valued functions.	K5
CO6	**Create** mathematical representations of functions in two variables using partial, total, and vector differentiation.	K6

CO	CO Description for Module II	Cognitive levels
CO1	**Remember** the definitions of vector spaces, subspaces, basis, dimension, and characteristic roots.	K1
CO2	**Understand** the properties of elementary matrices, the rank of matrix products, and the classification of quadratic forms.	K2
CO3	**Apply** row reduction and echelon forms to find the solution sets of systems of linear equations ().	K3

CO4	**Analyze** the relationship between row space, column space, and null space, including the standard theorems on matrix ranks.	K4
CO5	**Evaluate** eigenvalues and eigenvectors using the properties of characteristic roots and the Cayley-Hamilton theorem.	K5
CO6	**Create** canonical reductions of quadratic forms by determining their rank and signature.	K6