(Bachelor of Science) (Mathematics)
(B.Sc.) (Mathematics) Semester (VI)

Course Code	US06CMTH51	Title of the Course	Complex Analysis
Total Credits of the Course	4	Hours per Week	4 hours

Course Objectives:	1. This course aims to provide detailed knowledge of complex functions. 2. To study the techniques of complex variables and functions together with their continuity and differentiability. 3. To explain different transformations with examples.

Course Content		
Unit	Description	Weightage* (%)
1.	Complex functions: Exponential, Trigonometric, Hyperbolic, and Logarithmic functions, Limit of complex functions, Continuity of complex functions, Chain rule, and Differentiability of complex functions.	25%
2.	Cauchy-Riemann equations, Connection between C-R equations and Differentiability of complex functions, Sufficient conditions for differentiability, Analytic functions, Harmonic functions, Harmonic conjugate.	25%
3.	Properties of exponential, trigonometric, and logarithmic functions, Derivatives of exponential, trigonometric, and logarithmic functions, Inverse trigonometric functions, and hyperbolic functions.	25%
4.	Linear transformations, Bilinear transformation, Fixed points of bilinear transformation, The transformations $w = \frac{1}{z}, \sin z, e^z$.	25%

Teaching-Learning Methodology	Classroom teaching, Presentation by students, and Use of ICT whenever required.

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%

2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, and Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: After successful completion of the course, students will be able to:	
1.	Apply the basic knowledge of Complex Analysis in their future courses in Advanced Complex analysis, Differential equations, Functional analysis, etc.
2.	Analyze the limit, continuity, and differentiability of a function of complex variables and understand Conformal Mapping.
3.	Knowing complex analysis, students can understand many topics in signal processing and control theory.

Suggested References:

Sr. No.	References
1.	Brown, J. W., & Churchill, R. V. Complex Variables and Applications, Ninth Edition, McGraw-Hill Book Company, 2013.
2.	Conway J. B., Functions of One Complex Variable, Second Edition Narosa publ. House, New Delhi, 1996.
3.	Joseph B. and Donald J. N., Complex Analysis: Undergraduate texts in Mathematics Third Edition, Springer-Verlag, New York, Inc., New York, 2010.

On-line resources to be used if available as reference material

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(Bachelor of Science) (Mathematics)
(B.Sc.) (Mathematics) Semester (VI)

Course Code	US06CMTH52	Title of the Course	Linear Algebra
Total Credits of the Course	4	Hours per Week	4 hours

Course Objectives:	1. To understand the concepts of vector spaces, subspaces, bases, dimension and their properties. 2. To study of linear transformation, representation of linear transformation by matrices 3. To learn properties of inner product spaces and determine orthogonality in inner product spaces.

Course Content		
Unit	Description	Weightage* (%)
1.	Vector Spaces, Subspaces, Linear Combination, Span, Linear Dependence, Independence, Basis and Dimension for Vector Space and its examples	25%
2.	Linear Transformations and its examples, Kernel and Range of Linear Transformation, Nullity, Rank, Rank-nullity theorem for Linear Transformation, Non-Singular, Composition of Linear transformation and its Examples.	25%
3.	Matrices, Matrix associated with a Linear Map, Linear Map associated With a Matrix, Rank, Nullity, dimension theorem for Matrix and its Examples.	25%
4.	Characteristic Roots, Canonical Form, Inner Product Spaces and its properties, Orthogonal set, Orthonormal Set, Gram Schmidt theorem and its examples.	25%

Teaching-Learning Methodology	Classroom teaching, Presentation by students, Use of ICT whenever required.

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%

2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Upon completion of the course, the students will be able to…	
1.	Recognize and use of basic properties of subspaces and vector spaces and determine a basis and the dimension of a finite-dimensional space.
2.	Compute linear transformations, kernel and range, and inverse linear transformations, and find matrices of general linear transformations.
3.	Create orthogonal and orthonormal bases by Gram-Schmidt process.

Suggested References:	
Sr. No.	References
1.	V. Krishnamurthy, V.P. Mainra, J. L. Arora , An introduction to Linear Algebra, Affiliated East-West Press PVT LTD, New Delhi, 2013.
2	N. S. Gopalakrishnan, University Algebra, 2nd Edition, New Age International Publisher, 2016.
3	I. N. Herstein, Topics in Algebra, 2nd Edition, Wiley Eastern Ltd., New Delhi, 1975.
4	S. Kumaresan, Linear Algebra-A Geometric Approach, Prentice-Hall of India Pvt. Ltd, New Delhi, 2004.
5	A. Ramchandra Rao, P. Bhimashankaram, Linear Algebra, 2nd Edition, Tata McGraw-Hill, New Delhi, 1992.

On-line resources to be used if available as reference material
On-line Resources

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(Bachelor of Science) (Mathematics)
(B.Sc.) (Mathematics) Semester (VI)

Course Code	US06CMTH53	Title of the Course	Ring Theory
Total Credits of the Course	4	Hours per Week	4 hours

Course Objectives:	1. To introduce the fundamental concepts in ring theory such as the concepts of ideals, quotient rings, integral domains, and fields. 2. To demonstrate the concepts of the Euclidean Domain and relevant theorems. 3. To learn in detail about polynomial rings, and the fundamental properties of the field extensions.

Course Content		
Unit	Description	Weightage* (%)
1.	Rings, Properties of Ring, Zero Divisor, Integrals Domains, Field, Ring Isomorphism, Ring Homomorphism, Kernel of Ring Homomorphism, Quotient Fields	25%
2.	Ideals for Ring, Proper Ideal, Quotient Rings, First Isomorphism Theorem for Ring, Prime and Maximal Ideals, Factorization, Associates Elements, Irreducible Element, Prime Element, G.C.D.	25%
3.	Euclidean Domain, Principal Ideal Domain, Unique Factorization Domain, Introduction and definition of polynomial, degree of the polynomial, operation between polynomials, Polynomial Rings, Integral domain D[x].	25%
4.	Roots of polynomials, Factorization of polynomials, Division algorithm for polynomials, Irreducibility of a polynomial over Field, Remainder and factor theorem, Eisenstein's Criterion for irreducibility, Rational roots of polynomial, Primitive polynomial, Gauss Lemma, Gauss theorem, Rational function, Field Extensions, Normal extensions, Separable extensions.	25%

Teaching-Learning Methodology	Classroom teaching, Presentation by students, and Use of ICT whenever required.

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%

2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, and Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: After successful completion of the course, students will be able to:	
1.	understand the fundamentals of Rings and Ideals.
2.	understand Euclidean Domains.
3.	understand Permutation Groups, Primitive Polynomials, and Field extensions.
4.	acquired skills to apply to understand concepts understood at (1), (2), (3), and (4) in solving relevant problems.

Suggested References:	
Sr. No.	References
1.	N. S. Gopalakrishnan, University Algebra, Second Edition, Wiley Eastern Ltd., New Delhi, 1994.
2.	I. N. Herstein, Topics in algebra, Second Edition, Wiley Eastern Limited, India, 1975.
3.	Joseph A. Gallian, Contemporary Abstract Algebra, Ninth Edition, Narosa Pub., House, New Delhi, 2017.
4.	AshaRani Singal, Algebra, R Chand & Co., New Delhi, 2010.

On-line resources to be used if available as reference material

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(Bachelor of Science) (Mathematics)
(B.Sc.) (Mathematics) Semester (VI)

Course Code	US06CMTH54	Title of the Course	Real Analysis-III
Total Credits of the Course	4	Hours per Week	4 hours

Course Objectives:	1. To introduce students to various classes of elementary functions 2. To introduce students to Riemann Integral and various classes of integrable functions 3. Introduce students to pointwise and inform convergences of sequence and series of functions.

Course Content		
Unit	Description	Weightage* (%)
1.	Elementary Functions: Exponential functions, logarithmic functions, generalized power functions, Trigonometric functions, inverse Trigonometric functions.	25%
2.	Riemann Integrals Definitions and Existence, Inequalities for Integrals, Refinement of Partitions, Darboux's Theorem for Integrals, Conditions for Integrability, Integrability of the Sum, Difference, Product, Quotient and Modulus of functions.	25%
3.	Integral as the limit of sums (Riemann Sums), Some Integrable functions, Integration and differentiation, The Primitive, The Fundamental Theorem of Integral Calculus, Mean Value Theorems of Integral, and Second Mean Value Theorem.	25%
4.	Pointwise Convergence, Uniform Convergence on an Interval, Tests for Uniform Convergence, Properties of Uniformly Convergent Sequences and Series, and The Weierstrass Approximation Theorem.	25%

Teaching-Learning Methodology	Classroom teaching, Presentation by students, and Use of ICT whenever required.

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%

2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, and Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: After successful completion of the course, students will be able to…	
1.	understand various classes of elementary functions, their expansions, and their properties.
2.	understand Riemann Integral and various conditions for the integrability of a function.
3.	understand Riemann Integral as the limit of a sum, the Fundamental Theorem of Integral Calculus, and Mean Value Theorems.
4.	understand Pointwise and Uniform convergence of sequence and series of functions and various tests for convergence.
5.	acquired skills to apply understanding of concepts understood at (1), (2), (3) and (4) in solving relevant problems.

Suggested References:

Sr. No.	References
1.	S. C. Malik, Principles of Real Analysis, Fifth Edition, New Age International, New Delhi, 2021.
2.	S. C. Malik and Savita Arora, Mathematical Analysis, Fifth Edition, New Age International Pvt. Ltd., New Delhi, 2019.
3.	R. G. Bartle, D. R. Sherbert, Introduction to Real Analysis, Fourth Edition, Wiley India Pvt. Ltd., New Delhi, 2011.
4.	Charles G. Denlinger, Elements of Real Analysis, Jones and Bartlett (Student Edition), 2011

On-line resources to be used if available as reference material

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(Bachelor of Science) (Mathematics)
(B.Sc.) (Mathematics) Semester (VI)

Course Code	US06CMTH55	Title of the Course	Mathematics Practical
Total Credits of the Course	8	Hours per Week	16 hours

Course Objectives:	1. To understand Python-Matplotlib. 2. To understand Python-Pandas Library. 3. To introduce students to Sagemath software which can be used as a tool for many mathematical operations. 4. To develop problem-solving skills at UG-level Mathematics.

Course Content		
Parts	Description	Weightage* (%) (Marks)
Part-1	Python: Matplotlib library Introduction to matplotlib, graph titles, axes labels, legends, Line and Bar graphs, Pie and Polar graphs, plotting well-known graphs like, cartesian, trigonometric, parametric, etc	25% (50 Marks)
Part-2	Python: Pandas Library Introduction and importance of Pandas library, Read and write tabular data, Creating Dataframe, manipulating Dataframes, Reading tables, reshape and combine data from multiples tables, create plots in pandas.	25% (50 Marks)
Part-3	Sagemath Introduction to Sagemath, Basic inbuilt functions used in mathematics, Symbolic variables, finding solution of equations, solving system of equations, finding the limit of functions, a derivative of functions and integration of functions, programming for finding roots of equations using numerical methods.	25% (50 Marks)
Part-4	Problems & Exercises in Mathematics - II **Matrices:** systems of linear equations, rank, nullity, rank-nullity theorem, inverse, determinant, eigenvalues, eigenvectors. **Finite Dimensional Vector Spaces**: linear independence of vectors, basis, dimension, linear transformations, matrix representation, range space, null space, rank-nullity theorem.	25% (50 Marks)

	Differential Equations: Bernoulli's equation, exact differential equations, integrating factors, orthogonal trajectories, homogeneous differential equations, method of separation of variables, linear differential equations of second order with constant coefficients, method of variation of parameters, Cauchy-Euler equation.	

Teaching-Learning Methodology	Classroom teaching, Practical on Computers, Use of ICT whenever required.

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage%
1.	Internal Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Practical Examination	70%

Course Outcomes: Upon completion of the course, the students will be able to…	
1.	use Python- Matplotlib library for mathematical and statistical data types to plot/draw/graph.
2.	learn some primary codes using the Pandas library which can be used in data science, Machine Learning, and Artificial Intelligence.
3.	learn Sage math programming (It has inbuilt Mathematical functions) to solve Mathematical problems.
4.	get benefits in different competitive examinations of Mathematics.

Suggested References:	
Sr. No.	References
1.	https://matplotlib.org/stable/tutorials/index
2.	https://pandas.pydata.org/docs/user_guide/index.html
3.	https://doc.sagemath.org/html/en/tutorial/tour.html
4.	V. Krishnamurthy, V.P. Mainra, J. L. Arora , An introduction to Linear Algebra, Affiliated East-West Press PVT LTD, New Delhi, 2013.
5.	I. N. Herstein, Topics in Algebra, 2nd Edition, Wiley Eastern Ltd., New Delhi, 1975.
6.	M. D. Raisinghania, Ordinary and Partial differential equations, 20th Edition, S. Chand & Company Ltd., New Delhi, 2020.
7.	S. S. Sastri, Engineering Mathematics, 4th Edition, Phi Learning Private Limited, New Delhi, 2008.
On-line resources to be used as reference material	

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