



SIR P. T. SARVAJANI COLLEGE OF SCIENCE (Autonomous)
SURAT-395001
(Affiliated with Veer Narmad South Gujarat University, Surat)



Semester- II



Core Course- IV (CC-IV)

COURSE TITLE: COMPLEX ANALYSIS

COURSE CODE: MHMSC-S2P4-4CR24 [CREDITS - 04]

Course learning outcome		
At the end of this course, Students will be able to		
<ol style="list-style-type: none"> 1. Learn the algebra and geometry of complex numbers. 2. Check differentiability and the analyticity of complex valued function. 3. Understand Cauchy-Riemann relations and harmonic functions. 4. Understand Cauchy integral formula, general form of Cauchy theorem. 5. Learn Fundamental theorem of Algebra, Maximum module Principle 6. Understand Contour integrals related theorem and Examples. 7. Understand series expansion. 		
Module 1 Algebra of Complex Numbers		[15L]
Learning Objective		
1. To learn about basic concept of complex numbers.		
Learning Outcomes:		
At the end of this module the learner will be able to		
1. Understand the algebra and geometry of complex numbers.		
1.1	Introduction, Complex Numbers, Properties, Geometric representation, Conjugate, Triangle Inequality and its Applications, Polar and Exponential forms.	[8L]
1.2	Powers and Roots, Region in the Complex Plane, Open set, Limit point, Connected set, Pathwise connected set, Bounded set, Extended Complex Plane.	[7L]
Module 2 Analytic Functions		[15L]
Learning Objective		
1. To acquire the knowledge of differentiability, limit and continuity of complex function.		
Learning Outcomes:		
At the end of this module the learner will be able to		
1. Check differentiability and the analyticity of complex valued function.		
2.1	Functions of a Complex variables, Limit concept for complex-valued functions, Limit at infinity, Infinite limit, Continuity, Uniform continuity, Differentiability, Chain rule, Cauchy-Riemann Equations, Polar form of C-R equations, Analytic functions, Harmonic functions.	[15L]
Module 3 Elementary Functions		[15L]
Learning Objective		
1. To gain the knowledge of various types of complex functions.		
Learning Outcomes:		
At the end of this module the learner will be able to		
1. Understand about complex functions and their properties.		
3.1	Introduction, Periodic functions, Exponential function, Trigonometric functions, Hyperbolic functions, Multivalued function and its branches	[8L]
3.2	Logarithmic function, Complex Exponents, Inverse Trigonometric, Inverse Hyperbolic functions.	[7L]



Module 4 Complex Integration		[15L]
Learning Objective		
1. To learn Contour integrals related theorem and Examples		
Learning Outcomes:		
At the end of this module the learner will be able to		
1. Understand Contour integrals related theorem and Examples.		
4.1	Contour Integral, Primitives, Cauchy-Goursat Theorem, Extension of Cauchy-Goursat Theorem, Winding Number, Cauchy Integral formula, Consequences of Cauchy Integral formula, Concept of Maximum Moduli of functions.	[8L]
4.2	Series Expansions: Power Series, Uniform convergence of power series, Taylor series, Zeros of Analytic functions, Laurent Series.	[7L]

References:

1. H. S. Kasana: Complex Variables – Theory and Applications, 2nd Edition (2006), PHI, N. Delhi.
2. James Ward Brown & Ruel V. Churchill: complex Variables and Applications, McGraw-Hill, 8th Edition.
3. S. Ponnuswamy: Foundation of Complex Analysis, Narosa Publishing House, 1997.
4. J. N. Sharma: Functions of a Complex Variable, Krishna Prakashan, 2014
5. S. Lang: Complex Analysis, Addition Wesley, 4th Edition, 1997.
6. H. A. Priestly: Introduction to Complex Analysis, Clarendon Press, 1990
7. J. B. Conway: Functions of one Complex Variable, Springer-Verlag, 1980

Mapping of COs and PSOs

Course Learning Outcomes	Programme Outcomes							
	1	2	3	4	5	6	7	8
Learn the algebra and geometry of complex numbers.	X	X	X					
Check differentiability and the analyticity of complex valued function.	X	X	X			X	X	
Understand Cauchy-Riemann relations and harmonic functions.	X	X	X	X		X	X	
Understand Cauchy integral formula, general form of Cauchy theorem.	X	X			X	X	X	
Learn Fundamental theorem of Algebra, Maximum module Principle	X	X			X	X	X	
Understand Contour integrals related theorem and Examples.	X	X	X			X	X	
Understand series expansion.	X	X	X					



Practical:

Practical-1	Examples based on Triangle Inequality, Polar and Exponential forms.
Practical-2	Finding roots in complex plane.
Practical-3	Exercise on Limits, Continuity, Differentiability.
Practical-4	Examples based on Cauchy-Riemann Equations, Analytic functions, Harmonic functions.
Practical-5	Examples on Exponential function, Trigonometric functions, Hyperbolic functions, Multivalued function.
Practical-6	Examples on Logarithmic function, Complex Exponents, Inverse Trigonometric and Hyperbolic functions.
Practical-7	Examples based on Cauchy-Goursat Theorem, Extension of Cauchy-Goursat Theorem, Cauchy Integral formula.
Practical-8	Examples on Series Expansions.



Core Course- V (CC-V)

COURSE TITLE: LINEAR ALGEBRA

COURSE CODE: MHMSC-S2P5-4CR24 [CREDITS - 04]

Course learning outcome		
<p>At the end of this course, Students will be able to</p> <ol style="list-style-type: none"> 1. Discuss in detail the basic concepts of Linear dependence, basis and dimension of a vector space. The students will be able to demonstrate how the geometric ideas turn into rigorous proofs. 2. Capture the idea of producing lot of structure preserving maps (Linear transformations). Further the study of algebras of linear maps would be accomplished. 3. Having got trained in numerous examples the student realizes the isomorphic theory of linear transformations and matrices. 4. Understand the Linear polynomial and Eigenvalues-vector and algebra of polynomials. 5. Understand real and complex inner product space and theorems and to solve the examples using the theorems 		
Module 1		[15L]
Vector Space and Linear Transformations		
Learning Objective		
<ol style="list-style-type: none"> 1. To learn about concepts of a vector space and Linear Transformations. 		
Learning Outcomes:		
<p>At the end of this module the learner will be able to</p> <ol style="list-style-type: none"> 1. Discuss in detail the basic concepts of Linear dependence, basis and dimension of a vector space. 2. Capture the idea of producing lot of structure preserving maps (Linear transformations). Further the study of algebras of linear maps would be accomplished. 		
1.1	Vector Spaces, Subspaces, Direct Sums, Spanning Sets and Linear Independence, The Dimension of a Vector Space, Ordered Bases and Coordinate Matrices, The Row and Column Spaces of a Matrix.	[7L]
1.2	Linear Transformations: Isomorphisms, The Kernel and Image of a Linear Transformation, Rank-Nullity Theorem, The Matrix of a Linear Transformation, Change of Bases for Linear Transformations, Equivalence of Matrices, Similarity of Matrices, Similarity of Operators, Invariant Subspaces.	[8L]
Module 2		[15L]
Isomorphism Theorems		
Learning Objective		
<ol style="list-style-type: none"> 1. To learn about Isomorphism of linear transforms. 		
Learning Outcomes:		
<p>At the end of this module the learner will be able to</p> <ol style="list-style-type: none"> 1. Having got trained in numerous examples the student realizes the isomorphic theory of linear transformations and matrices. 		
2.1	The Isomorphism Theorems: Quotient Spaces, The Universal Property of Quotients and the First Isomorphism Theorem, Quotient Spaces, Complements and Co-dimension, Additional Isomorphism Theorems, Linear Functional, Dual Bases, Reflexivity, Annihilators	[15L]



Module 3 Eigenvalues and Eigenvectors		[15L]
Learning Objective <ol style="list-style-type: none">To acquire the knowledge of linear operators, Eigenvalues and Eigenvectors.To understand Triangularizability Diagonalizable Operators, Projections, Algebra of Projections, Projections and Invariance.		
Learning Outcomes: <p>At the end of this module the learner will be able to</p> <ol style="list-style-type: none">Understand the Linear polynomial and Eigenvalues-vector and algebra of polynomials.		
3.1	Linear Operator, Characteristic Polynomial and Minimal Polynomial of an Operator, Eigenvalues and Eigenvectors, Geometric and Algebraic Multiplicities, The Jordan Canonical Form, Triangularizability Diagonalizable Operators, Projections, Algebra of Projections, Projections and Invariance.	[15L]
Module 4 Inner Product Space		[15L]
Learning Objective <ol style="list-style-type: none">To make students aware inner product space, The Projection Theorem and Best Approximations, Orthogonal Direct Sums, The Riesz Representation Theorem and make them able to solve the examples of it.		
Learning Outcomes: <p>At the end of this module the learner will be able to</p> <ol style="list-style-type: none">Understand real and complex inner product space and theorems.To solve the examples using the theorems.		
4.1	Real and Complex Inner Product Spaces, Norm and Distance, Isometries, Orthogonality, Orthogonal and Orthonormal Sets, The Projection Theorem and Best Approximations, Orthogonal Direct Sums, The Riesz Representation Theorem	[15L]

References:

- Kenneth Hoffman and Ray Alden Kunze, Linear Algebra, 2/e, Prentice Hall of India Private Limited, New Delhi, 1975
- V. Krishnamurthy, V.P. Mainra, J. L. Arora, Introduction to Linear Algebra, East West Press Ltd, 1985 (Reprint 2019)
- S. Kumaresan, Linear Algebra: A Geometric Approach, Prentice-Hall of India Ltd, 2004.
- A.R. Rao, P. Bhimashankaram, Linear Algebra, 2/e, Tata McGraw Hill, 2000.
- Edgar G. Goodaire, Linear Algebra-Pure & Applied World Scientific, Cambridge University Press India Ltd, 2014.



Mapping of COs and PSOs

Course Learning Outcomes	Programme Outcomes							
	1	2	3	4	5	6	7	8
Discuss in detail the basic concepts of Linear dependence, basis and dimension of a vector space. The students will be able to demonstrate how the geometric ideas turn into rigorous proofs.	X	X	X		X		X	X
Capture the idea of producing lot of structure preserving maps (Linear transformations). Further the study of algebras of linear maps would be accomplished.	X	X	X				X	
Having got trained in numerous examples the student realizes the isomorphic theory of linear transformations and matrices.	X	X	X	X		X	X	
Understand the Linear polynomial and Eigenvalues-vector and algebra of polynomials.	X	X	X		X	X		
Understand real and complex inner product space and theorems and to solve the examples using the theorems	X	X			X	X	X	

Practical:

Practical-1	Examples on vector space.
Practical-2	Examples on linear transformations.
Practical-3	Exercise on isomorphism theorems-1.
Practical-4	Exercise on isomorphism theorems-2.
Practical-5	Examples on Linear Operator.
Practical-6	Examples on Eigenvalues and Eigenvectors.
Practical-7	Examples based on Inner Product Spaces.
Practical-8	Examples on Orthogonality.



Core Course- VI (CC-VI)

COURSE TITLE: ANALYTIC NUMBER THEORY

COURSE CODE: MHMSC-S2P6-4CR24 [CREDITS - 04]

Course learning outcome		
At the end of this course, Students will be able to		
<ol style="list-style-type: none"> 1. Know about Arithmetic functions, Dirichlet multiplication and elementary theorems on Prime numbers. 2. Learn about Chebyshev's functions, divisor functions $d(n)$, Mangöldt function, Abel's identity 3. Analyze the number theoretic problems 		
Module 1	Arithmetical functions and Dirichlet multiplication	[15L]
Learning Objective		
<ol style="list-style-type: none"> 1. To learn about various functions in Number theory. 		
Learning Outcomes:		
At the end of this module the learner will be able to		
<ol style="list-style-type: none"> 1. Understand the Möbius function, Mangöldt function and its properties. 		
1.1	Basic introduction of the Möbius function $\mu(n)$ and the Euler totient function $\phi(n)$, relation connecting μ and ϕ , the Dirichlet product of two arithmetical functions (a.f.) and group structure w.r.t. this product, the Mangöldt function $\Lambda(n)$, Multiplicative arithmetical functions, the inverse of a completely multiplicative arithmetical functions.	[15L]
Module 2	Dirichlet multiplication and averages of Arithmetical functions	[15L]
Learning Objective		
<ol style="list-style-type: none"> 1. To gain the knowledge of Arithmetic functions. 		
Learning Outcomes:		
At the end of this module the learner will be able to		
<ol style="list-style-type: none"> 1. Understand Arithmetic functions, Dirichlet multiplication and elementary theorems on Prime numbers 		
2.1	Liouville's function $\lambda(n)$, the divisor functions $d(n)$ and $\sigma\alpha(n)$, the generalized convolutions, the big oh notation, Euler's summation formula, some elementary asymptotic formulas, the average order of divisor functions $d(n)$ and $\sigma\alpha(n)$, the average order of functions $\phi(n)$, $\mu(n)$, $\Lambda(n)$.	[15L]
Module 3	Averages of Arithmetical Functions and Chebyshev's functions	[15L]
Learning Objective		
<ol style="list-style-type: none"> 1. To make students aware about various types of the functions in number theory. 		
Learning Outcomes:		
At the end of this module the learner will be able to		
<ol style="list-style-type: none"> 1. Understand lattice points and functions and relation between two functions in number theory. 		
3.1	Euler's summation formula, Distribution of lattice points visible from the origin, the partial sums of a Dirichlet product, applications to $\mu(n)$ and $\Lambda(n)$, Chebyshev's functions $\psi(x)$ and $\vartheta(x)$, relation between $\psi(x)$, $\pi(x)$ and $\vartheta(x)$, Abel's identity.	[15L]



Module 4		Elementary theorems on the distribution of prime numbers	[15L]
Learning Objective			
1. To learn about elementary theorems on distributions of prime numbers.			
Learning Outcomes:			
At the end of this module the learner will be able to			
1. Understand prime number theorems and partial sums of the functions.			
4.1	Some equivalent forms of prime number theorem, lower and upper bounds for $\pi(n)$ and pn , Shapiro's Tauberian theorem and its applications, an asymptotic formula for the partial sums $\sum_{p \leq x}(1/p)$, the partial sums of function $\mu(n)$.		[15L]

References:

1. Tom M. Apostol: Introduction to Analytic Number Theory, Narosa Pub. House, New Delhi, 1998.
2. Mc Carthy P. J.: Introduction to Arithmetical function, Springer-Verlag, New York, 1986.
3. K. Chandrashekharan: Introduction to Analytic Number Theory, Springer-Verlag, New York, 1968.
4. Hua L. K.: Introduction to Number Theory, Springer-Verlag, New York, 1982.

Mapping of COs and PSOs

Course Learning Outcomes	Programme Outcomes							
	1	2	3	4	5	6	7	8
Know about Arithmetic functions, Dirichlet multiplication and elementary theorems on Prime numbers.	X	X	X				X	
Learn about Chebyshev's functions, divisor functions $d(n)$, Mangöldt function, Abel's identity	X	X	X		X		X	
Analyse the number theoretic problems	X	X	X		X	X	X	

Practical:

Practical-1	Exercise on Möbius function $\mu(n)$, Euler totient function $\phi(n)$.
Practical-2	Exercise on Mangöldt function $\Lambda(n)$, Multiplicative a.f..
Practical-3	Exercise on Liouville's function $\lambda(n)$, the divisor functions $d(n)$ and $\sigma\alpha(n)$.
Practical-4	Exercise on the average order of divisor functions $d(n)$ and $\sigma\alpha(n)$, the average order of functions $\phi(n)$, $\mu(n)$, $\Lambda(n)$.
Practical-5	Examples on Distribution of lattice points visible from the origin, the partial sums of a Dirichlet product.
Practical-6	Examples on Chebyshev's functions $\psi(x)$ and $\vartheta(x)$, relation between $\psi(x)$, $\pi(x)$ and $\vartheta(x)$, Abel's identity.
Practical-7	Examples based on Equivalent forms of prime number theorem, lower and upper bounds for $\pi(n)$ and pn .
Practical-8	Examples on Shapiro's Tauberian theorem.



Elective Course- 2 (EC-V)

COURSE TITLE: NON-LINEAR ORDINARY DIFFERENTIAL EQUATIONS

COURSE CODE: MHMSC-S2E5-4CR24 [CREDITS - 04]

Course learning outcome		
At the end of this course, Students will be able to		
<ol style="list-style-type: none"> 1. Find linear approximation at equilibrium points 2. Solve simple nonlinear differential equation using averaging methods. 3. Solve some nonlinear differential equation using perturbation methods. 4. Understand different types of linear systems and their solutions. 5. Solve linear systems by various methods like Poincare stability solutions. 		
Module 1	First order systems in two variables	[15L]
Learning Objective		
<ol style="list-style-type: none"> 1. To learn about system of differential equations of first order in two variables and solution of it. 		
Learning Outcomes:		
At the end of this module the learner will be able to		
<ol style="list-style-type: none"> 1. Understand and solve First order systems in two variables and linearization. 		
1.1	First order systems in two variables and linearization: The general phase plane, Equilibrium points, Constant solutions, some population models, Linear approximation at equilibrium points, Linear systems in matrix form.	[15L]
Module 2	Averaging Methods	[15L]
Learning Objective		
<ol style="list-style-type: none"> 1. To gain the knowledge of solution of an energy balance method for limit cycles and periodic solutions. 		
Learning Outcomes:		
At the end of this module the learner will be able to		
<ol style="list-style-type: none"> 1. Solve simple nonlinear differential equation using averaging methods. 		
2.1	An energy balance method for limit cycles, Amplitude and frequency estimates, slowly varying amplitudes, nearly periodic solutions, periodic solutions.	[8L]
2.2	Harmony balance, Equivalent linear equation by harmonic balance, Accuracy of a period estimate.	[7L]
Module 3	Perturbation Methods	[15L]
Learning Objective		
<ol style="list-style-type: none"> 1. To get the knowledge of how to solve non linear differential equations by direct methods. 		
Learning Outcomes:		
At the end of this module the learner will be able to		
<ol style="list-style-type: none"> 1. Solve some nonlinear differential equation using perturbation methods. 		
3.1	Outline of the direct method, Forced Oscillations far from resonance, Forced Oscillations near resonance with Weak excitation.	[7L]
3.2	The amplitude equation for undamped pendulum, Amplitude Perturbation for the pendulum equation, Lindstedt's Method, Forced oscillation of a self-excited equation, The Perturbation Method and Fourier series.	[8L]



Module 4 Linear Systems		[15L]
Learning Objective		
1. To get the knowledge of different types of linear systems.		
Learning Outcomes:		
At the end of this module the learner will be able to		
1. Understand different types of linear systems and their solutions.		
4.1	Time Varying Systems, Constant coefficient System, Periodic Coefficients, Floquet Theory, Wronskian.	[7L]
4.2	Stability: Poincare stability, solutions, paths and norms, Liapunov stability Stability of linear systems, Comparison theorem for the zero solutions of nearly, linear systems.	[8L]

References:

1. D.W. Jordan & P. Smith, Nonlinear Ordinary Differential Equations, 4/e, Oxford University Press, 2007.
2. G. F. Simmons, Differential Equations with Applications and Historical Notes, 3/e, CRC Press, 2017.
3. D.A.Sanchez, Ordinary Differential Equations and Stability Theory, 1/e, Dover Publications, 2012.
4. J.K.Aggarwal, Notes on Nonlinear Systems, D. Van Nostrand, 1972.

Mapping of COs and PSOs

Course Learning Outcomes	Programme Outcomes							
	1	2	3	4	5	6	7	8
Find linear approximation at equilibrium points.	X	X	X		X		X	X
Solve simple nonlinear differential equation using averaging methods.	X	X	X				X	
Solve some nonlinear differential equation using perturbation methods.	X	X	X			X	X	
Understand different types of linear systems and their solutions.	X	X		X		X		X
Solve linear systems by various methods like Poincare stability solutions.	X	X	X		X	X	X	



Practical:

Practical-1	Exercise on First order systems in two variables-1.
Practical-2	Exercise on First order systems in two variables-2.
Practical-3	Examples on An energy balance method for limit cycles.
Practical-4	Examples based on Harmony balance - Equivalent linear equation by harmonic balance.
Practical-5	Solve some nonlinear differential equation using perturbation methods.
Practical-6	Examples based on Lindstedt's Method.
Practical-7	Examples based on Linear Systems-1.
Practical-8	Examples based on Linear Systems-2.



Elective Course-2 (EC-VI)

COURSE TITLE: GRAPH THEORY

COURSE CODE: MHMSC-S2E6-4CR24 [CREDITS - 04]

Course learning outcome		
At the end of this course, Students will be able to		
<ol style="list-style-type: none"> 1. Understand and work on the fundamental concepts of graphs. 2. Apply graph theory based tools in solving practical problems. 3. Understand basic concepts in Trees and discuss matching problems and its applications elsewhere. 		
Module 1	Introductory concepts	[15L]
Learning Objective		
<ol style="list-style-type: none"> 1. To learn about fundamental concepts of graphs. 		
Learning Outcomes:		
At the end of this module the learner will be able to		
<ol style="list-style-type: none"> 1. Understand and work on the fundamental concepts of graphs 		
1.1	Basic Concepts, Diagrammatic Representation of a Graph, Finite graph, Infinite graph, Isomorphism, Simple Graphs and Isomorphism, Subgraphs, Degrees of Vertices, Paths and Connectedness, Operations on Graphs, Directed Graphs: Basic Concepts, Tournaments.	[15L]
Module 2	Connectivity	[15L]
Learning Objective		
<ol style="list-style-type: none"> 1. To gain the knowledge of connectivity and basic concept of Counting the Number of Spanning Trees. 		
Learning Outcomes:		
At the end of this module the learner will be able to		
<ol style="list-style-type: none"> 1. Understand basic concepts in Trees and discuss matching problems and its applications elsewhere. 		
2.1	Vertex Cuts and Edge Cuts, Connectivity and Edge Connectivity, r-connected, Blocks, Ear decomposition of a block, Cyclical Edge Connectivity of a Graph.	[8L]
2.2	Definition, Characterization and Simple Properties, Centers and Centroids, Counting the Number of Spanning Trees, Cayley's Formula.	[7L]
Module 3	Matching , Eulerian and Hamilton Graphs	[15L]
Learning Objective		
<ol style="list-style-type: none"> 1. To learn about Matching problems and Eulerian Graphs & Hamiltonian Graphs. 		
Learning Outcomes:		
At the end of this module the learner will be able to		
<ol style="list-style-type: none"> 1. Understand the matching problems and its applications elsewhere. 2. Understand Eulerian Graphs and Hamiltonian Graphs. 		
3.1	Vertex Independent Sets and Vertex Coverings, Edge Independent Sets, Matchings in Bipartite Graphs, Matchings and Factors.	[8L]
3.2	Eulerian Graphs, Euler trail, Euler tour, Hamiltonian Graphs.	[4L]
Module 4	Graph Colorings	[15L]
Learning Objective		
<ol style="list-style-type: none"> 1. To get the knowledge of Graph Colouring. 		
Learning Outcomes:		
At the end of this module the learner will be able to		
<ol style="list-style-type: none"> 1. Understand Colorings of Graphs like Vertex Coloring, Edge Colorings. 		
4.1	Vertex Colorings, Application of Graph colorings, Critical Graphs, Brook's theorem, Triangle-Free Graphs.	[8L]



4.2	Edge Colorings of Graphs, Vizing's theorem, Snarks, Kirkman's Schoolgirl Problem, Chromatic Polynomials.	[7L]
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References:

1. R. Balakrishnan, K. Ranganathan, A Textbook of Graph Theory, 2/e, Springer International Edition, New Delhi, 2008.
2. J.A. Bondy, U.S.R. Murty, Graph Theory with Applications, 5/e, Macmillan Press Ltd., 1982.
3. Gary Chartrand, Linda Lesniak, Ping Zhang, Graphs and Digraph, 6/e, CRC press, 2016.
4. Douglas B. West, Introduction to Graph Theory, 2/e, Pearson Edu. (P) Ltd., 2002.

Mapping of COs and PSOs

Course Learning Outcomes	Programme Outcomes							
	1	2	3	4	5	6	7	8
Understand and work on the fundamental concepts of graphs.	X	X	X	X	X	X		
Apply graph theory based tools in solving practical problems.	X	X	X	X	X	X		X
Understand basic concepts in Trees and discuss matching problems and its applications elsewhere.	X	X	X	X	X			X

Practical:

Practical-1	Examples based on fundamental concepts of graphs -1.
Practical-2	Examples based on fundamental concepts of graphs -2.
Practical-3	Exercise on Vertex Cuts and Edge Cuts - Connectivity and Edge - Connectivity, Blocks.
Practical-4	Examples: Counting the Number of Spanning Trees - Cayley's Formula.
Practical-5	Based on Independent Sets -Matchings and Factors.
Practical-6	Examples: Eulerian Graphs - Hamiltonian Graphs.
Practical-7	Examples: Vertex Coloring.
Practical-8	Examples: Edge Coloring.



Elective Course-2 (EC-VII)

COURSE TITLE: ADVANCED INTEGRAL TRANSFORMS TECHNIQUES

COURSE CODE: MHMSC-S2E7-4CR24 [CREDITS - 04]

Course learning outcome		
At the end of this course, Students will be able to		
<ol style="list-style-type: none"> 1. Familiar with the basic concepts of Students will be able to learn about Hankel transform, Finite Hankel transforms. 2. Understand applications of Hankel transforms. 3. Solve the partial differential equations using Hankel transforms. 4. Learn about Hilbert and Stieltjes transforms. 5. Solve differential equations using Hilbert and Stieltjes transforms. 6. Know conceptual knowledge of Z-transforms and properties of Z- transforms. 7. Analyze Mellin Transform of derivative of a function, Mellin Transform of Integral of a function. 		
Module 1	Hankel Transforms	[15L]
Learning Objective		
<ol style="list-style-type: none"> 1. To gain the knowledge on some of the basic concept of Hankel transform and finite Hankel transform. 		
Learning Outcomes:		
At the end of this module the learner will be able to		
<ol style="list-style-type: none"> 1. learn the concepts of Hankel transform and its properties and Finite Hankel transforms with its properties. 		
1.1	Introduction, Hankel transform and Examples, operational properties of the Hankel transform.	[3L]
1.2	Introduction, Definition of the finite Hankel transform and its examples.	[4L]
1.3	Finite Hankel transforms of some elementary functions.	[4L]
1.4	Basic operational properties of the finite Hankel transform.	[4L]
Module 2	Applications of Hankel transforms	[15L]
Learning Objective		
<ol style="list-style-type: none"> 1. know and understand the applications of Hankel Transform. 		
Learning Outcomes:		
At the end of this module the learner will be able to		
<ol style="list-style-type: none"> 1. solve various differential equations using Hankel transform and Finite Hankel transforms. 		
2.1	Applications of Hankel transforms to partial differential equations	[7L]
2.2	Applications of finite Hankel transforms	[8L]
Module 3	Hilbert and Stieltjes Transforms	[15L]
Learning Objective		
<ol style="list-style-type: none"> 1. Understand concept and use of Hilbert and Stieltjes Transform. 		
Learning Outcomes:		
At the end of this module the learner will be able to		
<ol style="list-style-type: none"> 1. solve differential equations using Hilbert and Stieltjes Transform. 		
3.1	Introduction and definition of Hilbert transform and examples, Basic properties of Hilbert transform	[3L]
3.2	Definition of Stieltjes transforms and examples, Basic properties of Stieltjes transforms	[4L]



3.3	Inverse theorem for Stieltjes transforms, Applications of Stieltjes transforms	[4L]
3.4	The generalized Stieltjes transform, Basic properties of the generalized Stieltjes transform	[4L]
Module 4	Z-transform and Mellin Transform	[15L]
Learning Objective 1. Understand concept of Z-transform and Mellin Transform.		
Learning Outcomes: At the end of this module the learner will be able to 1. know conceptual knowledge of Z-transforms and properties of Z- transforms. 2. analyze Mellin transform of derivative of a function and Mellin transform of Integral of a function.		
4.1	Definition and properties, Z-transform of some standard functions, initial and final value theorems.	[5L]
4.2	Convolution theorem, Some operational properties of Z-Transform, Application of Z-Transforms.	[5L]
4.3	Definition of Mellin transform, Mellin Transform of derivative of a function, Mellin transform of Integral of a function.	[5L]

References:

1. L. Debnath and D.D. Bhatta, Integral Transforms and their Applications, 2/e, CRC Pub., 1995.
2. Baidyanath Patra, An Introduction to Integral Transforms, 1/e, CRC Press, Taylor Francis Group, 2018.
3. Poularikas, A. D., The Transforms and Applications, Handbook, 2/e, CRC Press, 1996.
4. M.Ya.Antimirov, A.A.Klyshkin, R. Valliancourt, Applied Integral Transforms, CRM Monograph Series, American mathematical Society, 2007.
5. B. Davies: Integral Transforms and their applications, 3/e, Springer - Verlag, 1978.
6. Ian Sneddon: The use of Integral Transform, TMIH, 1979.
7. A.R.Vasishta and R.K.Guptha, Integral Transforms, Krishna Prakashan Media, 2016
8. Kanwal, R.P. and Sneddon, I.N, Fourier Transforms, Dover publication, 2010.
9. Spiegel, M.R.: Theory and Problems of Laplace transforms, Schaum's series, 2011
10. Boas M. L.: Mathematical Methods in Physical Sciences, 3/e, John Wiley & Sons, 1983.
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12. Andrews, L. G. & Shivamoggi B. K.: Integral Transforms for Engineers, PHI, 2003.



Mapping of COs and PSOs

Course Learning Outcomes	Programme Outcomes							
	1	2	3	4	5	6	7	
Familiar with the basic concepts of Students will be able to learn about Hankel transform, Finite Hankel transforms.	X		X			X	X	
Understand applications of Hankel transforms.	X	X	X			X	X	
Solve the partial differential equations using Hankel transforms.	X	X	X			X	X	
Learn about Hilbert and Stieltjes transforms.	X	X		X		X		X
Solve differential equations using Hilbert and Stieltjes transforms.	X	X		X		X		X
Know Conceptual Knowledge of Z-transforms and properties of Z- transforms.	X	X		X	X	X		
Analyze Mellin Transform of derivative of a function, Mellin Transform of Integral of a function.	X		X		X	X	X	

Practical:

Practical-1	Practical based on Hankel Transform-1
Practical-2	Practical based on Finite Hankel Transform-1
Practical-3	Practical based on Applications of Hankel transform-1
Practical-4	Practical based on Applications of Hankel transform-1
Practical-5	Practical based on Hilbert Z-transform
Practical-6	Practical based on Stieltjes Transform
Practical-7	Practical based on Z-transform
Practical-8	Practical based on Mellin Transform



Skill based elective/Value Added Course- 2 (SEC-V)

COURSE TITLE: Differential Geometry-2

COURSE CODE: MHMSC-S2SEC1-4CR24 [CREDITS - 02]

Course learning outcome		
At the end of this course, Students will be able to		
<ol style="list-style-type: none"> 1. Interpret the geometric meaning of the angle of intersection in terms of curvature and orientation. 2. Analyze the behavior of curves in a family, including geodesics and curvature lines. 		
Module 1	Intrinsic geometry of Surface	[15L]
Learning Objective		
<ol style="list-style-type: none"> 1. Explore the geometric properties of surfaces, including curvature, normal vectors, and tangential planes. 		
Learning Outcomes:		
At the end of this module the learner will be able to		
<ol style="list-style-type: none"> 1. Interpret the geometric meaning of the angle of intersection in terms of curvature and orientation. 		
1.1	First fundamental quadratic form of a surface, Angle of two intersecting curves in a surface, element of area, Family of curves in a surface, principle directions, isometric surfaces, The Riemannian curvature tensor, the Gaussian curvature of a surface.	[15L]
Module 2	Surfaces in Space	[15L]
Learning Objective		
<ol style="list-style-type: none"> 1. Explore applications of families of curves in surface mapping and differential geometry. 		
Learning Outcomes:		
At the end of this module the learner will be able to		
<ol style="list-style-type: none"> 1. Analyze the behavior of curves in a family, including geodesics and curvature lines. 		
2.1	Second fundamental form of a surface, Equation of Gauss and equations of Codazzi, Normal curvature of surface, lines of curvature of a surface, Isometric conjugate nets, Dupin indicatrix.	[15L]



References:

1. J. A. Thorpe, Elementary topics in differential geometry, 2/e, Springer, 2004.
2. A. Pressley, Elementary differential geometry, 2/e, Springer, 2010.
3. Mittal and Agarwal, Differential geometry, 36/e, Meerut: Krishna Prakashan Media (P) Ltd., 2010.
4. K. S. Amur, D. J. Shetty and C. S. Bagewadi, An introduction to differential geometry, Oxford, U.K: Alpha Science International, 2010.

Mapping of COs and PSOs

Course Learning Outcomes	Programme Outcomes							
	1	2	3	4	5	6	7	8
Interpret the geometric meaning of the angle of intersection in terms of curvature and orientation.				X	X	X		X
Analyze the behavior of curves in a family, including geodesics and curvature lines.				X	X	X		X



Skill Based Elective/Value Added Course- 2 (SEC-VI)

COURSE TITLE: Math with Python-2

COURSE CODE: MHMSC-S2SEC2-4CR24 [CREDITS - 02]

Course learning outcome		
At the end of this course, Students will be able to		
<ol style="list-style-type: none"> 1. Be familiar with the built-in functions to deal with Graphs and Digraphs. 2. The built in functions required to deal with creating and visualizing Graphs, Digraphs, Multi Graph. 		
Module 1	Data Visualization Fundamentals	[7L]
Learning Objective		
<ol style="list-style-type: none"> 1. be aware of different types of plots in Python. 		
Learning Outcomes:		
At the end of this module the learner will be able to		
<ol style="list-style-type: none"> 1. deal with Graphs and Digraphs. 		
1.1	Standard plots (2D and 3D), Plotting with Matplotlib, pyplot interface, Scatter plots, Slope fields, Vector fields, Plotting more than one curve.	[7L]
Module 2	Advanced Data Visualization and Analysis	[8L]
Learning Objective		
<ol style="list-style-type: none"> 1. acquire the skill of creating graphs using functions of Python. 		
Learning Outcomes:		
At the end of this module the learner will be able to		
<ol style="list-style-type: none"> 1. Deal with creating and visualizing Graphs, Digraphs, Multi Graph using the built in functions. 		
2.1	Contour plots, stream lines, Manipulating and data visualizing data with Pandas, various examples using Pandas series.	[8L]

References:

1. H. P. Langtangen, A Primer on Scientific Programming with Python, 2/e., Springer, 2016.
2. S. Linge and H. P. Langtangen, Programming for computations- Python - A Gentle Introduction to Numerical Simulations with Python 3.6, 2/e, Springer Open, Second Edm., 2020.
3. H. Fangohr, Introduction to Python for Computational Science and Engineering (A beginner's guide), University of Southampton, 2015.
(<https://www.southampton.ac.uk/~fangohr/training/python/pdfs/Python-for-Computational-Science-and-Engineering.pdf>)
4. E Balagurusamy, Introduction to Computing & Problem Solving using Python, 1st ed., McGraw Hill Education (India) Private Limited, New Delhi.



Mapping of COs and PSOs

Course Learning Outcomes	Programme Outcomes							
	1	2	3	4	5	6	7	8
Be familiar with the built-in functions to deal with Graphs and Digraphs.			X	X	X	X		X
The built in functions required to deal with creating and visualizing Graphs, Digraphs, Multi Graph.			X	X	X	X		X

Practical:

Practical-1	Examples include line plots, bar charts, and histograms.
Practical-2	Scatter plots display individual data points on a two-dimensional plane.
Practical-3	Examples of velocity,
Practical-4	Examples of force, or electric field
Practical-5	Example of contour plot
Practical-6	Example of data visualization using pandas

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