

## **SYLLABUS**

For the course work syllabus recommended by  
the Guide for doing Ph.D in the  
Department of Mathematics,  
Sri Siddhartha Institute of Technology under  
SSU, Tumkur.

## **BASIC GRAPH THEORY**

**SUB CODE: 09MAT01**

**Total hours 52**

### **UNIT 1. GRAPHS**

**13hrs**

Definitions, incidence, adjacency and degree of a vertex. Types of graphs. Complete graph, bipartite graphs, complement graphs, self Complementary graph and Regular graphs. Isomorphism. Sub graphs, Walks, Paths, Circuits, Connected graphs, Disconnected Graphs, Components,

### **UNIT 2. BLOCKS AND TREES**

**12hrs**

Cut points, bridges and blocks. Block graphs and Cutpoint graphs. Definitions of trees, Properties, and Examples, Routed Trees, Trees and Sorting, Weighted Trees and Prefix Codes.

### **UNIT 3. PLANARITY**

**14hrs**

Combinatorial graph, planar graphs, Kuratowski's two graphs, different representations of a graph. Euler's polyhedral formula, detection on planarity, outer planar graphs, and other characterizations of planar graphs. Geometrical dual, more on criteria of planarity. Genus, thickness and crossing numbers.

### **UNIT 4. MATRIX REPRESENTATION AND DIAGRAPHs**

**13hrs**

Incidence matrix, adjacency matrix, sub matrices, circuit matrix, fundamental circuit matrix, and rank. Cut set matrix, path matrix, and relation between them. Types of Digraphs and Binary Relations. Directed Paths and Connectedness. Trees with directed Edges – Fundamental Circuits in Digraph – Matrices A, B, and C of Diagraphs – Adjacency Matrix of a Diagraph – Tournaments.

#### **Text books:**

1. Narsingh Deo, Graph theory with Application to Engineering and Computer science, Prentice`Hall of India Private Limited, New Delhi.
2. P. Grimaldi: Discrete and Combinatorial Mathematics, 5<sup>th</sup> Edition, Pearson Education, 2004.

#### **References:**

1. Harary. F, Graph Theory. Addison - Wesley, Reading, Mass (1969).
2. G. Chartand and Chang – Introduction to graph theory.

## ADVANCED GRAPH THEORY AND COMBINATORICS

**SUB CODE: 09MAT02**

**Total hours 52**

### **UNIT 1. LINE GRAPHS AND TRAVERSABILITY**

**13 hrs**

Definition of Line graphs, Some properties of line graphs, Characterization of line graphs, special line graphs, line graphs and Traversability, total graphs. 1-factorization, 2-factorization, arboricity. Partitions, Coverings and independence numbers.

Euler Graphs, Hamiltonian Paths and Circuits, The traveling Salesman Problem. Transport Networks, maximal flow, Max-Flow Min-Cut Theorem.

### **UNIT 2. COLORING AND DOMINATION NUMBER**

**14hrs**

Vertex coloring and edge coloring. Chromatic Number, Chromatic Polynomial, matching, coverings. The four Color Problem, maximal independent set, point independence number.

Domination, independence and irredundance. Efficiency, Redundancy and their duals. Changing and unchanging dominating set, varieties of domination, Dominating functions, Frame works for domination, domination complexity and algorithms.

### **UNIT 3. GENERATING FUNCTIONS AND RECURRENCE RELATIONS**

**13 hrs**

Introductory Examples Definition and Examples. Computational Techniques, Partitions of Integers, the Exponential Generating Function, the Summation Operator.

First Order Linear Recurrence Relation, The Second Order Linear Homogeneous Recurrence Relation with Constant Coefficients, the Non-homogeneous Recurrence Relation, The Method of Generating Functions.

### **UNIT 4. OPTIMIZATION AND COUNTING**

**12 hrs**

Dijkstra's Shortest Path Algorithm, Minimal Spanning Trees – The algorithms of Kruskal's and Prim, Transport Networks –Max-flow, Min-cut Theorem, Matching Theory.

The Rules of Sum and Product, Permutations, Combinations – The Binomial Theorem, Combinations with Repetition.

#### **Text book:**

1. P. Grimaldi: Discrete and Combinatorial Mathematics, 5<sup>th</sup> Edition, Pearson Education, 2004

#### **References:**

1. Harary.F, Graph Theory ,Addison - Wesley, Reading, Mass (1969).
2. Narsingh Deo, Graph theory with Application to Engineering and Computer science, Prentice Hall of India Private Limited, New Delhi.
3. Teresa W. Haynes, Stephen T. Hedetniemi, Peter J. Slater, "Fundamentals of Domination in graphs", Marcel Dekker, Inc. 2000.

## LINEAR ALGEBRA

**SUB CODE: 09MAT03**

**Total hours 52**

### **UNIT 1. DETERMINANTS AND MATRICES**

Definition, Minors, Cofactors, Laplace expansion, Properties of determinants, factor theorem, multiplication of determinants, Solution of linear system of equations using Cramer's rule.

Definition, types of matrices, equality of matrices, multiplication of matrices, transpose of a matrix, adjoint of a matrix, inverse of a matrix, solution of linear system of equations using matrix method, rank of a matrix, elementary matrix, normal form of a matrix, rank of a matrix.

### **UNIT 2. LINEAR SYSTEM OF EQUATIONS AND EIGEN VALUES**

Linear dependence, consistency of linear system of equations, inverse of matrix by partition method, characteristic equation, eigen values, eigen vectors, Cayley-Hamilton theorem.

### **UNIT 3. TRANSFORMATIONS AND COMPLEX MATRICES**

Linear transformation, orthogonal transformation, modal matrix, spectral matrix, matrix reduction to diagonal form ( $P^{-1}AP$ ), finding powers of a matrix, reduction of quadratic form to canonical form, complex matrices, conjugate of a matrix, Hermitian matrix, skew Hermitian matrix, Unitary matrix.

### **UNIT 4. VECTOR SPACES AND INNER PRODUCT SPACES**

Vector spaces, subspaces, bases and dimension. Coordinates, summary of row equivalence, computations concerning subspaces. Inner products spaces, orthogonal sets and projections. Gram-Schmidt process, QR-factorization, least squares problems, unitary operations.

#### **Text Book:**

1. Dr. B.S.Grewal, Higher Engineering mathematics, 39<sup>th</sup> Edition KHANNA Publishers.

#### **References:**

1. Kenneth Hoffman and Ray Kunze, "Linear Algebra" 2nd edition, Pearson Education (Asia) Pvt . Ltd/Prentice Hall of India, 2004.
2. David C Lay, Linear algebra and its applications , 3<sup>rd</sup> edition, Pearson Education, (Asia) Pte, Ltd 2005

## APPLIED MATHEMATICS

**SUB CODE: 09MAT04**

**Total hours 52**

### **UNIT 1. COMPLEX VARIABLES**

**15hrs**

Cauchy- Riemann equations in both forms, Analytic functions, harmonic functions, properties and their relation to velocity potential and stream function of potential flow. Geometrical representation of  $f(z)$ , some standard transformations, Conformal mapping techniques.

Complex line integrals, Cauchy's theorem, Cauchy's integral formula, Morera's theorem, Liouville's theorem, Taylor's and Laurent's series, zeros and singularities of an analytical function, Cauchy's residue theorem, calculation of residues, Schwarz – Christoffel theorem .

### **UNIT 2. DIFFERENTIAL EQUATIONS**

**15hrs**

Differential equations of first order, applications of differential equations of first order, linear differential equations, Applications of linear differential equations, differential equations of other types.

Formation of Partial differential equations, solution of partial differential equations, Nonlinear equation of the first order, Charpit's method, homogeneous linear equations with constant coefficients, rules for finding complementary function and particular integral.

### **UNIT 3. CALCULUS OF VARIATIONS**

**7hrs**

Calculus of variations- Introduction, Fundamental Theorem Functional of single function, Euler's equation, Geodesics. Applications to standard variational problems. Iso-perimetric and minimal surface problems. Variations of functional dependent on higher derivatives.

### **UNIT 4. TRANSFORMS**

**15hrs**

Basic definition; Z-transforms – definition, standard Z-transforms, damping rule, shifting rule, initial value and final value theorems. Inverse Z-transform. Application of Z-transforms to solve difference equations.

Infinite Fourier transform, Fourier Sine and Cosine transforms, properties, Inverse transforms.

#### **Text book:**

1. Dr. B.S.Grewal, Higher Engineering mathematics, 39<sup>th</sup> Edition KHANNA Publishers. (Chapters- IV, V, VII)

#### **References:**

1. E. Kreyszig: "Advances Engineering Mathematics" Wiley Eastern, 1976.
2. Peter V. O'Neil, Engineering Mathematics, CENGAGE Learning India Pvt Ltd. Publishers.

## **DISCRETE MATHEMATICS**

**SUB CODE: 09MAT05**

**Total hours 52**

### **UNIT 1. SET THEORY**

**13hrs**

Operations on Sets, laws of set theory, counting and Venn diagrams, countable and uncountable sets, addition principle, The concept of probability, mathematical induction and recursive definitions.

Properties of integers, Mathematical induction, the well ordering principle, recursive definitions.

### **UNIT 2. MATHEMATICAL LOGIC**

**14hrs**

Logical connectives truth table, Logical equivalence. Tautology and contradiction, laws of logic, logical implications, Rules of inference. The use of quantifiers, quantifiers, definitions, proofs and theorems.

### **UNIT 3. RELATIONS AND FUNCTIONS**

**13hrs**

Cartesian Products and Relations, Functions –Plain and One-to-One, Onto Functions – Sterling's Numbers of the Second Kind, Special Functions. Function, Composition and Inverse Functions.

Properties of Relations, Computer Recognition – Zero-One Matrices and Directed Graphs, Partial Orders – Hasse Diagrams, Equivalence Relations and Partitions.

### **UNIT 4. GROUP AND CODING THEORY**

**12hrs**

Binary operation. Groups and some properties of groups. Subgroups, cyclic groups, order of an element of a group. Coset decomposition of a group, Lagrange's theorem. Homomorphism and isomorphism. Elements of coding theory, the hamming metric, parity check and generator matrices. Group codes, decoding with coset leaders, Hamming matrices.

The Ring Structure – Definition and Examples, Ring Properties and Substructures, The Integers Modulo  $n$ .

#### **Text Book:**

1. Ralph P. Grimaldi- Discrete and combinatorial mathematics , 4<sup>th</sup> edition, pearson education, 2003.

#### **Reference books:**

1. C. L. Liu – Elements of Discrete Mathematics, McGraw-Hill, 1986.

2. Kenneth H. Rosen – Discrete Mathematics and its Applications, McGraw-Hill, 2002.