Unit I
Calculus of Variations
Introduction to variation problems - Euler’s equation - Functional dependent on first and higher order derivatives - Functional dependent on functions of several independent variables - Some applications - Direct methods: Ritz methods.

9 Hours

Unit II
Vector space
Definition and examples of linear space - Linear dependence and independence - Basis and Dimension - Inner product space - Orthogonalisation process - Gram - Schmidt process - Least - square problems - Applications of inner product spaces.

9 Hours

Unit III
Eigen values and Eigen vectors
Generalized Eigen values and Eigen vectors - Characteristic equation - Diagonalization - Eigen vectors & linear transformations - Complex eigen values - Applications to differential equations - Iterative estimates for Eigen values.

9 Hours

Unit IV
Symmetric Matrices and Quadratic forms
Diagonalization of symmetric matrices - Quadratic forms - Singular values decomposition - Change of basis.

9 Hours

Unit V
Graph Theory

9 Hours
Total:45+15 Hours

Reference(s):
Unit I
Vector Spaces
Vector spaces and subspaces – Linearity independent sets – Bases – Dimensions – Change of bases – Approximation to co-ordinate systems.

9 Hours

Unit II
Linear Transformations

9 Hours

Unit III
Inner Product Spaces

9 Hours

Unit IV
Eigenvalues and Eigenvectors

9 Hours

Unit V
Symmetric Matrices and Quadratic Forms
Diagonalization of symmetric matrices – Quadratic forms – Singular values decomposition – Applications to image processing.

9 Hours

Total: 45 + 15 Hours

Reference(s)


Unit I

Fundamental Structures


12 Hours

Unit II

Logic

Propositional logic – Logical connectives – Truth tables – Normal forms (conjunctive and disjunctive) - Predicate logic - Universal and existential quantifiers - Proof techniques – Direct and indirect – Proof by contradiction – Mathematical Induction.

12 Hours

Unit III

Modeling Computation and Languages

Finite state machines – Deterministic finite state machines (DFA) and Non-deterministic finite state machines (NFA) – Equivalence of DFA and NFA - Formal Languages – Classes of Grammars – Type 0-Context sensitive – Context free- Regular Grammar.

12 Hours

Unit IV

Graph Theory

Introduction to Graphs-Graph operations - Graph and Matrices – Graph Isomorphism – Connected Graphs – Euler Graphs - Hamilton paths and circuits – Shortest path problem.

12 Hours

Unit V

Queue Models

Characteristics of Queueing Models- Kendal’s Notation - Single and Multi-Server Markovian queuing models – M/M/1, M/M/C (finite and infinite capacity) and ( M/G/1) : (∞/GD) - Queuing applications.

12 Hours

Total: 60 Hours

References:


Unit I
Fundamental Structures

Unit II
Logic
Propositional logic – Logical connectives – Truth tables – Normal forms (conjunctive and disjunctive) - Predicate logic - Universal and existential quantifiers - Proof techniques – Direct and indirect – Proof by contradiction – Mathematical Induction.

Unit III
Combinatorics
Basics of counting – Counting arguments – Pigeonhole principle - Permutations and Combinations - Recursion and Recurrence relations – Generating functions.

Unit IV
Modeling Computation and Languages

Unit V
Finite State Automata
Finite State Automata- Deterministic Finite State Automata (DFA), Non Deterministic Finite State Automata (NFA) – Equivalence of DFA and NFA – Equivalence of NFA and Regular Languages.

References:

Unit I
Probability and Random Variables
Probability concepts – Random Variables – Moment generating function – Standard distributions - Binomial - Poisson - Rectangular or Uniform – Normal - Exponential distributions - Functions of random variables - Two dimensional random variables.

9 Hours

Unit II
Stochastic Processes

9 Hours

Unit III
Queue Models
Characteristics of Queueing Models- Kendal’s Notation-Single and Multi-Server Markovian queuing models M/M/1, M/M/C (finite and infinite capacity) and ( M/G/1) : (∞/GD) - Queuing applications.

9 Hours

Unit IV
Simulation and Applications

9 Hours

Unit V
Classical Optimization Theory

9 Hours

Total: 45+15= 60 Hours

References
Unit I
Basic Concepts in Graph Theory
Graph-degree of a vertex- degree sequence- sub graphs- vertex induced sub graphs. Complement of a graph- self complementary graphs- walk- path- connectivity- eccentricity- radius- diameter- vertex and edge cuts- vertex partition- Independent set- clique.

12 Hours

Unit II
Special Classes of Graphs

12 Hours

Unit III
Eulerian and Hamiltonian Graphs

12 Hours

Unit IV
Linear Programming
Definition- Simplex-Two-phase simplex- Big M-method and Dual simplex algorithms.

12 Hours

Unit V
Dynamic Programming
Multistage decision process- Computational procedure-Final and Initial value problems- Continuous Dynamic programming- Discrete Dynamic programming.

12 Hours

Total: 60 Hours

Reference(s)
Unit I
Solution of System of Linear and Nonlinear Equations and Curve Fitting
Solution of system of linear equations: Gauss Elimination Method, Choleski Method, Iterative Methods, Relaxation Method- System of Non-Linear Equations-: Newton Raphson Method- Least Square Approximation- Fitting of Non-Linear Curves By Least Squares.

12 Hours

Unit II
Numerical Integration: Newton-Cotes Integration
Numerical Integration : Trapezoidal rule, Simpson's rules, Gaussian quadrature, adaptive integration, cubic spline functions - Bezier curves and B-splines.

12 Hours

Unit III
Boundary Value Problems and Characteristic Value Problems
Introduction - Shooting method, solution through a set of equations, derivative boundary conditions, Rayleigh-Ritz method, characteristic value problems, solution using characteristic polynomial method, Jacobi method, power method and Inverse power method.

12 Hours

Unit IV
Numerical Solutions of Stationary Partial Differential Equations
Laplace's equation: Laplace's equations, representations as a difference equation, Iterative methods for Laplace's equations, Poisson equation, derivative boundary conditions, irregular and non-rectangular grids, Matrix patterns, ADI method, applications to two dimensional heat flow problems.

12 Hours

Unit V
Parabolic and Hyperbolic Partial Differential Equations:
Introduction-Crank-Nicholson method, explicit method, derivative boundary condition, stability and convergence criteria, Parabolic equations in two or more dimensions, applications to one dimensional heat flow problems- Hyperbolic Partial differential equations: Solving wave equation by finite differences, stability of numerical method, method of characteristics, Wave equation in two space dimensions

12 Hours
Total: 60 Hours

Reference(s)
Unit I  
**Advanced Matrix Theory**  

12 Hours

Unit II  
**Calculus of Variations**  
Introduction to calculus of variational problems - Euler’s equation - Functional dependent on first and higher order derivatives - Functional dependent on functions of several independent variables - Some applications - Direct methods: Ritz and Kantorovich methods.  

12 Hours

Unit III  
**Fourier Series**  
Euler’s formula - Dirichlet’s conditions - General Fourier series - Fourier series expansion to different types of wave forms - change of intervals - Harmonic Analysis.  

12 Hours

Unit IV  
**Fast Fourier Transform**  
Discrete convolution - Periodic sequence and circular convolution - Linear convolution through circular convolution - Discrete Fourier series and discrete Fourier transform - Fast Fourier transform - Decimation in time algorithm - Decimation in frequency algorithm - Inverse DFT.  

12 Hours

Unit V  
**Soft Computing Techniques.**  
Genetic Algorithm - ANT colony Optimization - Particle Swam Optimization.  

12 Hours

Total: 60 Hours

**Reference Books:**

Unit – I
**Differentiation, integration and matrices**
First order and second order differential equations, functions - applications in Biological Sciences, Integrating factors and Bernoulli equations, Linear ODE’s with constant coefficients: Numeric integration and differentiation - exposure to software packages like Matlab or Scilab: Basics: vectors, matrices, determinants; Matrix addition and multiplication.

9 Hours

Unit – II
**Curve fitting**
Curve Fitting -fitting a straight line and second degree curve, Correlation and Regression. fitting a non linear curve, Bivariate correlation - application to Biological Sciences.

9 Hours

Unit –III
**Design of Experiments**
Design of Experiments – One way, two way classifications – Randomized Block Designs-Latin Square Designs – biological samples

9 Hours

Unit –IV
Sampling distributions - Large samples and Small samples. Testing of Null hypothesis-Z test, t test and \( \chi^2 \) test. Type I and Type II errors. Fisher’s F Test. Goodness of fit.

9 Hours

Unit-V
Design of Experiments –One way, Two way classifications – Randomized Block Designs-Latin Square Designs.

9 Hours

Total: 45 Hours

References: