CREDIT STRUCTURE & SYLLABI
OF
COURSES OFFERED
BY
MATHEMATICS AND SCIENTIFIC COMPUTING
DEPARTMENT
FOR
UNDER GRADUATE PROGRAMME
(MATHEMATICS COURSES)
&
POST GRADUATE PROGRAMME
(MATHEMATICS COURSES)

DEPARTMENT OF MATHEMATICS AND SCIENTIFIC COMPUTING
MADAN MOHAN MALAVIYA UNIVERSITY OF TECHNOLOGY, GORAKHPUR-273010, UP

CREDIT STRUCTURE & SYLLABI

for

Under Graduate Programme (For Mathematics Courses)

&

Post Graduate Programme (For Mathematics Courses)

S.N.	Paper Code	Subject	Prerequisite subject	L	T	P	Credits
Under Graduate Programme							
1.	BMS-01	Engineering Mathematics-I	-	3	1	0	4
2.	BMS-02	Engineering Mathematics-II	-	3	1	0	4
3.	BMS-03	Graph Theory	-	3	1	2	5
4.	BMS-04	Engineering Mathematics-III	-	3	1	0	4
5.	BMS-05	Discrete Mathematics	-	3	1	0	4
6.	BMS-06	Applied Computational Methods	-	3	1	2	5
7.	BMS-07	Advanced Mathematics and Statistics		3	1	0	4
8.	BMS-08	Engineering Mathematics-IV	-	3	1	0	4
9.	BMS-09	Optimization Techniques	-	3	1	0	4
10	BMS-10	Numerical Methods	-	3	1	2	5
Open Elective							
11	BOE-03	Operations Research	_	3	1	0	4
Post Graduate Programme							
12	MMS-601	Numerical Methods and Engineering Optimization	-	3	1	2	5
13	MMS-602	Business Statistics	-	3	1	0	4
14	MMS-603	Mathematical foundations of computer science	-	3	1	0	4
15	MMS-604	Applied Probability and Statistics	-	3	1	0	4
16	MMS-605	Discrete Mathematics	-	3	1	0	4
17	MMS-606	Advanced Engineering Mathematics	-	3	1	0	4
18	MMS-607	Applied Computational Mathematics		3	1	2	5
19	MMS-608	Operations Research for Business Decisions	-	3	1	0	4
20	MMS-609	Probabilistic Modelling	-	3	1	2	5

BMS-01 ENGINEERING MATHEMATICS-I

Course category	:	Basic Sciences & Maths (BSM)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes and One Minor tests and One Major Theory Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Use of basic differential operators in various engineering problems.
2. Solve linear system of equations using matrix algebra.
3. Use vectors to solve problems involving force, velocity, work and real-life problems and able to analyze vectors in space
4. Evaluate and use double integral to find area of a plane region and us of triple integral to find the volume of region in 3rd dimension

Topics Covered

UNIT-I

Differential Calculus: Leibnitz theorem, Partial derivatives, Euler's theorem for homogenous function, Total derivative, Change of variable. Taylor's and Maclaurin's theorem. Expansion of function of two variables, Jacobian, Extrema of function of several variables. 9

UNIT-II

Linear Algebra: Rank of Matrix, Inverse of a Matrix, Elementary transformation, Consistency of linear system of equations and their solution. Characteristic equation, Eigen-values, Eigen-vectors, Cayley-Hamilton theorem. 9

UNIT-III

Multiple Integrals: Double and triple integrals, change of order of integration, change of variables. Application of multiple integral to surface area and volume. Beta and Gamma functions, Dirichlet integral. 9

UNIT-IV

Vector Calculus: Gradient, Divergence and Curl. Directional derivatives, line, surface and volume integrals. Applications of Green's, Stoke's and Gauss divergence theorems (without Proofs). 9

Books & References

1. B.S. Grewal: Higher Engineering Mathematics; Khanna Publishers.
2. B.V. Ramana: Higher Engineering Mathematics, Tata Mc. Graw Hill Education Pvt. Ltd., New Delhi.
3. H.K. Dass and Rama Verma: Engineering Mathematics; S. Chand Publications.
4. N.P. Bali and Manish Goel: Engineering Mathematics; Laxmi Publications.

BMS-02 ENGINEERING MATHEMATICS – II

Course category	:	Basic Sciences & Maths (BSM)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture : 3, Tutorial : 1 , Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes and One Minor tests and One Major Theory Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Use of various mathematical techniques such as differential operators, matrix algebra and vector differentiation and integration.
2. To identify, formulate and solve the real life problems.
3. To inculcate the habit of mathematical thinking and lifelong learning.

Topics Covered

UNIT-I 9

Differential Equations: Linear differential equations with constant coefficients ($n^{th} order$), complementary function and particular integral. Simultaneous linear differential equations, solution of second order differential equations by changing dependent and independent variables, Method of variation of parameters, Applications of differential equations to engineering problems

UNIT-II 9

Special functions: Series solution of second order differential equations with variable coefficient (Frobeneous method). Bessel and Legendre equations and their series solutions, Properties of Bessel function and Legendre polynomials

UNIT-III 9

Laplace Transform: Laplace Transform, Laplace transform of derivatives and integrals. Unit step function, Laplace transform of Periodic function. Inverse Laplace transform, Convolution theorem, Applications to solve simple linear and simultaneous differential equations.

UNIT-IV 9

Fourier Series and Partial Differential Equations: Periodic Functions, Fourier Series of period 2π, Change of interval, Even and Odd functions, Half range Sine and Cosine Series. Harmonic analysis, Partial Differential Equations with constant coefficients

Books & References

1. Higher Engineering Mathematics - B.S. Grewal, Khanna Publishers
2. Engineering Mathematics - H.K. Dass and Rama Verma, S. Chand Publications
3. Engineering Mathematics - N.P. Bali and Manish Goel, Laxmi Publications
4. Higher Engineering Mathematics - B.V. Ramana, Tata McGraw Hill Education Pvt. Ltd., New Delhi.

BMS-03 GRAPH THEORY

Course category	:	Basic Sciences & Maths (BSM)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical: 2
Number of Credits	:	5
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce and One Minor tests and One Major Theory & Practical Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Write precise and accurate mathematical definitions of objects in graph theory.
2. Use a combination of theoretical knowledge and independent mathematical thinking in creative investigation of questions in graph theory.
3. Use mathematical definitions to identify and construct examples.
4. Validate and critically assess a mathematical proof.

Topics Covered

UNIT-I 9

Preliminaries: Sets, relations, functions & multi-sets, Inductive definition and proof by induction, Cardinality of sets Basic concepts of Graph Theory: Digraphs, graphs and other similar objects, Representations of diagraphs and graphs, Operations on graphs, degree sequence and isomorphism Connectedness and distance: Walks, trails, circuits, cycles, and paths, Connected digraphs and graphs, Weighted graphs and digraphs and distance

UNIT-II 9

Trees and their applications: Basic properties of trees and forests, Minimum-weight spanning trees, Enumeration of labeled trees, Rooted trees and uniquely decipherable coding, Tree traversals and parentheses-free notations Networks and flows: Legal flows and capacities of cuts, The Ford-Fulkerson Algorithms and Maxflow-Mincut theorem

UNIT-III 9

Edge and Vertex traversal problems: Euler circuits and Euler trails, Fleury's algorithm and the Chinese Postman problem, Hamilton cycles and the Travelling Salesman problem Planar embeddings of graphs: Basic properties of planar graphs, Kuratowski's theorem and non-planar graphs, The DMP planarity algorithm, Polyhedral graphs and geometric dual

UNIT-IV 9

Colorings and Matchings in graphs: Legal colorings and k-colorable graphs, Chromatic Polynomial and Fourcolor theorem, Matchings in graphs and Stable marriage algorithm Directed graphs: Tournaments, directed paths and cycles, connectivity and strongly connected digraphs, branching, Infinite graphs and digraphs

EXPERIMENTS

1. Write a recursive program that computes the value of ln(N!).
2. Write a C program to Implement Euler Circuit which starts and ends on the same vertex.
3. Write a C Program to Implement Hamiltonian Cycle Algorithm.
4. Write a C Program to assign a colour to each of the states so that no two adjacent states share the same colour. The program should output each state and its colour. Example: Alabama touches Florida, Mississippi, Tennessee, and Georgia. Arkansas touches Louisiana, Texas, etc.

5. Graph implementation of BFS and DFS using C. 56
6. Write a C Program to Implement Euler Circuit problem. In graph theory, this starts and ends on the same vertex.
7. Write a C Program for the 'marriage problem', for N boys and N girls and an NxN binary matrix telling us which pairings are suitable, and want to pair each girl to a boy. Implement perfect matching in a bipartite graph.
8. Write a C program to implement ford-fulkerson algorithm
9. Write A C program for the implementation of the Branch and Bound Algorithm: The Asymmetric Travelling Salesman Problem
10. Write a C program for Dijkstra's Algorithm for Finding Shortest Paths in Non-Negative Weight Graphs.
11. Write a C program to check whether the given graph is tree.
12. Write a C program to extract spanning tree (without using Kruskal and prim's Algorithm).
13. Write a C program to perform following operations on a given 2 connected graph i. Union ii. Intersection iii. deletion of a vertex iv. deletion of any edge v. fusion of 2 vertex
14. Write a C program to input an image (Graph) and find out its adjacency and incidence matrix.
15. Write a C program to extract walk, path from any vertex to any vertex in a given graph.
16. Write a C program for the i. test for emptyness ii. return the number of vertices iii. return the number of edges iv. test if a given vertex exists v. test if a given edge exists vi. add a vertex (this operation does not add any edge) vii. add an edge (this operation may result in adding new vertices) viii. delete a vertex (this operation may result in deleting edges) ix. delete an edge (this operation may result in deleting vertices)

Textbooks & Reference books

1. Graphs and Hypergraphs -Berge, C., New York: Elsevier, 1973.
2. Theory of Graphs and Its Applications - Berge, C., New York: Wiley, 1962.
3. Modern Graph Theory- Bollobás, B., New York: Springer-Verlag, 1998.

BMS 04 ENGINEERING MATHEMATICS-III

Course category	:	Basic Sciences & Maths (BSM)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes and One Minor tests and One Major Theory Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Use of Residue theorem and Integral formula to evaluate various integrals.
2. Use of moments and kurtosis to find the type of curve.
3. To interpolate a curve using Gauss, Newton's interpolation formula.
4. To find the derivative of a curve and area of a curve.

Topics Covered

UNIT-I 9

Functions of Complex Variable: Analytic function, C-R equations, Cauchy-Integral Theorem, Cauchy-Integral formula, Taylor's Series and Laurent Series, Zero's and Singularities, Residue theorem, Evaluation of the real integrals of the type $\int_0^{2\pi} f(\cos\theta, \sin\theta)d\theta$ *and* $\int_{-\infty}^{+\infty} f(x)dx$.

UNIT-II 9

Statistical Techniques: Moments, Generating function for moments, Skewness, Kurtosis, and Curve fitting: Method of Least Squares, Fitting of Straight lines and Parabola. Correlation and Regression. Binomial Distribution, Poisson's Distribution, and Normal Distributions.

UNIT-III 9

Numerical Techniques: Solution of polynomial equations by Bisection, Regula-Falsi and Newton-Raphson's methods. Interpolation: Newton's forward and backward interpolation formulae, Lagrange's and Newton's divided difference methods for unequal intervals.

UNIT-IV 9

Solution of Linear and Differential equations and Numerical Integration: Solution of linear equations by Crout's method and Guass-Siedel method. Solution of ordinary Differential equations by Euler's, Picard's and Fourth order Runge-Kutta methods. Numerical Integration by Trapezoidal, Simpson's one-third and Simpson's three-eight rules.

Books & References

1. B.S. Grewal - Higher Engineering Mathematics; Khanna Publishers.
2. B.V. Ramana - Higher Engineering Mathematics, Tata McGraw Hill Education Pvt. Ltd., New Delhi
3. H.K. Dass and Rama Verma - Engineering Mathematics; S. Chand Publications
4. N.P. Bali and Manish Goel - Engineering Mathematics; Laxmi Publications.

BMS- 05 DISCRETE MATHEMATICS

Course category	:	Basic Sciences & Maths (BSM)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes and One Minor tests and One Major Theory Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Use logical notation to define different function such as set, function and relation.
2. Use of basic properties of group theory in computer science.
3. Use of graph theory models to solve problems of connectivity and constraint satisfaction, for example, scheduling.
4. Use of induction hypotheses to prove formulae.

Topics Covered

UNIT-I 9

Set Theory, Relation and Function: Definition of sets, Countable and uncountable sets, Venn Diagrams, Proofs of some general identities on sets. Definition and types of relation, composition of relation, equivalence relation, partial order relation. Function: Definition, types of function, one to one, into and onto function, inverse function, composition of functions.

UNIT-II 9

Algebraic Structures: Definition, properties and types of algebraic structures, Semi groups, Monoid, Groups, Abelian group, properties of groups, Subgroups, Cyclic groups, Cosets, Factor group, Permutations groups, Normal subgroups, examples and standard results. Rings and fields: Definition and Standard results.

UNIT-III 9

Graphs: Simple graph, multigraph, graph terminology, representation of graphs, Bipartite, regular, planar and connected graphs, connected components in a graph, Euler graphs, Hamiltonian path and circuits, graph colouring, chromatic number, chromatic polynomials. Tree: types and definition, rooted tree, properties of trees.

UNIT-IV 9

Combinatorics: Basic counting Technique, Pigeon-hole principle, Discrete Numeric function, Recurrence relations and their solution, Generating function, Solution of recurrence relations by method of generating function.

Books & References

1. J.P. Tremblay and R. Manohar, Discrete Mathematical Structures with applications to computer science, Tata McGraw-Hill.
2. D. Narsingh, Graph Theory with application to engineering and computer science - Prentice Hall
3. V. Krishnamurthy, Combinatorics: Theory and applications -, East East-West Press PVT. LTD, 1985

BMS-06 APPLIED COMPUTATIONAL METHODS

Course category : Basic Sciences & Maths (BSM)
Pre-requisite Subject : NIL
Contact hours/week : Lecture: 3, Tutorial: 1, Practical: 2
Number of Credits : 5
Course Assessment methods : Continuous assessment through tutorials, attendance, home assignments, quizzes and One Minor tests and One Major Theory & Practical Examination
Course Outcomes : The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. To find the root of a curve using Bisection, Regula falsi Newton's Method.
2. Use of moments and kurtosis to find the type of curve.
3. To interpolate a curve using Gauss, Newton's interpolation formula.
4. To find the derivative of a curve.
5. To find the area of a curve.

Topics Covered

UNIT-I 9

Numerical Methods: Solution of algebraic and Transcendental equations, Bisection method, Method of False position (Regula-Falsi method) and Newton-Raphson method, Solution of linear simultaneous equations; Guass-Siedel method, Crout's method.

UNIT-II 9

Interpolation and Numerical Integration: Interpolation: Finite Differences, Difference operators, Newton's forward and backward interpolation formulae, Lagrange's formula for unequal intervals, Newton's divided difference formula for unequal intervals. Numerical Integration: Trapezoidal Rule, Simpson's one-third and three-eight rules.

UNIT-III 9

Numerical Solution of Ordinary Differential Equations and Difference Equations: Picard's method, Taylor's Series method, Euler's method, Modified Euler's method, Runge-Kutta method of order four. Difference equations and their solutions. Rules for finding the particular integral.

UNIT-IV 9

Statistical Methods and Probability Distributions: Frequency Distributions, mean, mode, median, standard deviation, Moments, Skewness, Kurtosis, Types and measurement of Skewness and Kurtosis. Correlation; Regression and regression lines. Binomial Distribution, Poisson's Distribution, Normal Distribution.

Experiments

1. To implement Regula-Falsi method to find root of algebraic equation.
2. To implement Newton-Raphson method to find root of algebraic equation.
3. To implement Newton's Divided Difference formula to find value of a function at a point.
4. To implement Numerical Integration by using Simpson's one-third rule.
5. To implement numerical solution by using Runge-Kutta method of order four to find solution of differential equation.
6. To implement numerical solution of differential equation by Picard's method.
7. To implement numerical solution of differential equation by using Euler's method.
8. To estimate regression equation from sampled data and evaluate values of standard deviation, regression coefficient.

Books & References

1. B.S. Grewal: Higher Engineering Mathematics; Khanna Publishers.
2. B.V. Ramana: Higher Engineering Mathematics, Tata Mc. Graw Hill Education Pvt. Ltd., New Delhi.
3. H.K. Dass and Rama Verma: Engineering Mathematics; S. Chand Publications.
4. N.P. Bali and Manish Goel: Engineering Mathematics; Laxmi Publications.

BMS-07 Advanced Mathematics and Statistics

Course category	:	Basic Sciences & Maths (BSM)
Pre-requisites	:	NIL
Contact hours/week	:	Lecture : 3, Tutorial : 1
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, assignments, quizzes, One Minor tests and One Major Theory Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. To find the root of a curve using Bisection, Regula Falsi, Newton's Methods.
2. Use of moments and kurtosis to find the type of curve.
3. To interpolate a curve using interpolation formula.
4. Use of Fourier transforms and Z transforms to solve the differential equation.

Topics Covered

UNIT-I 9

Numerical Methods I: Solution of algebraic and transcendental equations by Bisection, Regula-Falsi, secant Method and Newton-Raphson methods. Newton's Gregory forward and backward interpolation, Lagrange's and Newton's divided difference method.

UNIT-II 9

Numerical Methods II: Solution of system of linear equations by Jacobi, Guass-Siedel method and Crout's method. Trapezoidal Rule, Simpson's one-third and three-eight rules. Solution of differential equations by Taylor, Picard, Euler, Runge-Kutta Fourth Order Methods, Milne's and Adam's predictor and corrector methods.

UNIT-III 9

Integral Transforms: Fourier integral, Complex Fourier transform, Inverse Transforms, Convolution theorem, Fourier sine and cosine transform, Applications of Fourier transform to simple one-dimensional heat transfer equation, wave equation.

Z- transform and its application to solve difference equations

UNIT-IV 9

Statistical Methods and Probability Distributions: Frequency Distributions, mean, mode, median, standard deviation, Moments, Skewness, Kurtosis, Types and measurement of Skewness and Kurtosis. Correlation; Regression and regression lines. Binomial Distribution, Poisson's Distribution, Normal Distribution.

Textbooks

1. B.S. Grewal: Higher Engineering Mathematics; Khanna Publishers.
2. B.V. Ramana: Higher Engineering Mathematics, Tata Mc. Graw Hill Education Pvt. Ltd., New Delhi.

Reference books

1. P. Kandasamy, K. Thilagavathi, K. Gunavathi., Numerical Methods*:* S. Chand & Company.
2. N.P. Bali and Manish Goel: Engineering Mathematics; Laxmi Publications.
3. Beri - Business Statistics (Tata Mc. Graw Hill 2nd edition).

BMS-08 ENGINEERING MATHEMATICS-IV

Course category	:	Basic Sciences & Maths (BSM)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes and One Minor tests and One Major Theory Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Use of Laplace Transform to solve the differential equation.
2. Use of Fourier transforms and Z transforms to solve the differential equation.
3. To solve the partial differential equations using Lagrange and charpits metghod.
4. Application of partial differential equation in real life problems

Topics Covered

UNIT-I 9

Integral Transform I: Laplace Transform Laplace transform, Existence theorem, Laplace transforms of derivatives and integrals, Initial and final value theorems, Unit step function, Dirac- delta function. Laplace transform of periodic function, Impulse function.

Inverse Laplace transform, Convolution theorem, Application to solve simple linear and simultaneous differential equations.

UNIT-II 9

Integral Transform II: Fourier integral, Complex Fourier transform, Inverse Transforms, Convolution Theorems, Fourier sine and cosine transform, Applications of Fourier transform to simple one dimensional heat transfer equation, wave equation.

Z- transform and its application to solve difference equations

UNIT-III 9

Partial Differential Equations

Partial differential equations of the first order, Lagrange's solution, Charpit's general method of solution, Partial differential equations of the second order: Constant coefficient and reducible to constant coefficient, Classification of linear partial differential equations of second order.

UNIT-IV

Applications of Partial Differential Equations: Method of separation of variables for solving partial differential equations, Wave equation up to two-dimensions, Laplace equation in two dimensions, Heat conduction equations up to two dimensions 9

Books & References

1. B.S. Grewal - Higher Engineering Mathematics; Khanna Publishers.
2. B.V. Ramana - Higher Engineering Mathematics, Tata McGraw Hill Education Pvt. Ltd., New Delhi
3. H.K. Dass and Rama Verma - Engineering Mathematics; S. Chand Publications
4. N.P. Bali and Manish Goel - Engineering Mathematics; Laxmi Publications

BMS-09 OPTIMIZATION TECHNIQUES

Course category	:	Basic Sciences & Maths (BSM)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes and One Minor tests and One Major Theory Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. To find the root of a curve using iterative methods.
2. To interpolate a curve using Gauss, Newton's interpolation formula.
3. Use the theory of optimization methods and algorithms developed for various types of optimization problems.
4. To apply the mathematical results and numerical techniques of optimization theory to Engineering problems.

Topics Covered

UNIT-I 9

Classical Optimization Techniques: Single variable optimization, Multi-variable with no constraints. Non-linear programming: One Dimensional Minimization methods. Elimination methods: Fibonacci method, Golden Section method.

UNIT-II 9

Linear Programming: Constrained Optimization Techniques: Simplex method, Solution of System of Linear Simultaneous equations, Revised Simplex method, Transportation problems, Karmarkar's method, Duality Theorems, Dual Simplex method, Decomposition principle.

UNIT-III 9

Non-Linear Programming: Unconstrained Optimization Techniques: Direct search methods: Random jumping method, Univariate method, Rosenbrock's method. Indirect search methods: Steepest Descent method, Cauchy-Newton Methods, Newton's method.

UNIT-IV 9

Geometric Programming: Polynomial, Unconstrained minimization problem, Degree of difficulty. Solution of an unconstrained **Geometric** Programming problem. Constrained minimization complementary Geometric Programming, Application of Geometric Programming.

Books & References

1. S.S. Rao; Engineering Optimization, New Age International
2. E.J. Haug and J.S. Arora; Applied Optimal Design, Wiley New York
3. Kalyanmoy Deb; Optimization for Engineering Design, Prentice Hall of India

BMS-10 NUMERICAL METHODS

Course category	:	Basic Sciences & Maths (BSM)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture : 3, Tutorial : 1 , Practical: 2
Number of Credits	:	5
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes and One Minor tests and One Major Theory & Practical Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. To find the root of a function using Bisection, Regula falsi, Newton's Method, Aitken's method.
2. To interpolate a curve using Gauss, Newton's interpolation formula.
3. To solve the first order boundary value problem.
4. To solve a definite integral using numerical approach.

Topics Covered

UNIT-I 9

Roots of equation: Bisection method, Regula Falsi Method, Secant Method, Fixed point Iteration Method, Newton Raphson Method, Modified Newton Raphson Method for Multiple roots, derivation of rate of convergence, Aitken Method.

UNIT-II 9

Solutions of system of Linear equations and Eigen Value problem: Linear equations: Direct method for solving systems of linear equations (Gauss elimination, Gauss Jordan, LU Decomposition, Cholesky Decomposition), Iterative methods (Jacobi, Gauss Seidel, Relaxation method). Algebraic Eigen value problem: Power method, Jacobi's method, Given's method.

UNIT-III 9

Numerical Quadrature: Relationship in various difference operators, Newton Gauss Forward and Backward Interpolation, Lagrange and Newton divided difference interpolation, Newton Cotes Formula, trapezoidal Rule, Simpson's 1/3 and 3/8 rule, Gauss Quadrature Formula, Chebyehev's Formula, Piecewise Linear Interpolation, Cubic Spline Interpolation.

UNIT-IV 9

Numerical solution of Ordinary differential equations and, Difference Equation: Single Step Methods: Taylor, Picard, Euler, Runge-Kutta Fourth Order Methods. Multistep methods: Milne's and Adam's predictor and corrector methods. Difference equations and their solutions, Rules for finding the particular integral.

EXPERIMENTS

1. To implement Regula-Falsi method to find root of algebraic equation.
2. To implement Newton-Raphson method to find root of algebraic equation.
3. To implement Newton's Divided Difference formula to find value of a function at a point.
4. To implement Numerical Integration by using Simpson's one-third rule.
5. To implement numerical solution of differential equation by Picard's method.
6. To implement numerical solution of differential equation by using Euler's method.
7. To implement numerical solution of differential equation by using Runge – Kutta Method.

Books & References

1. M.K. Jain, S.R.K. Iyenger and R.K. Jain, Numerical Methods:, New Age Publishers.
2. P. Kandasamy, K.Thilagavathi, K.Gunavathi , Numerical Methods., S. Chand & Company.
3. B.S. Grewal; Higher Engineering Mathematics, Khanna Publishers, Delhi.
4. B.V. Ramana; Higher Engineering Mathematics, Tata Mc. Graw Hill Education Pvt. Ltd., New Delhi

BOE-03 OPERATIONS RESEARCH

Course category	:	Open Electives (OE), MSCD
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes and One Minor tests and One Major Theory Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Identify and develop operational research models from the verbal description of the real system.
2. Be able to build and solve Transportation Models and Assignment Models.
3. Knowledge of formulating mathematical models for quantitative analysis of managerial problems in industry
4. Aware with the basic concepts and tools of game theory and can apply these tools to real-life situations.

Topics Covered

UNIT-I 9

Linear Programming

Two variable linear programming model and Graphical method of solution, Simplex method, Dual Simplex method, Special Cases of linear programming duality, Sensitivity Analysis, OR Model, solving the OR model.

UNIT-II 9

UNIT-II: Transportation Problems

Types of transportation problems, Mathematical models, Transportation algorithms.

Assignment: Allocation and assignment problems and models, Processing of jobs through machines.

UNIT-III 9

Network Techniques

Shortest path model minimum spanning tree problems, Max-Flow problem, Min-cut problem.

Project Management: Phase of Project Management, guidelines of network construction, CPM and PERT.

UNIT-IV 9

Game Theory and Quality Systems

Rectangular games, Minimax theorem, graphical solution of 2xn or mx2 games, game with mixed strategies, reduction to linear programming model, Elements of Queuing model, generalized Poisson Queuing model, Single Server model.

Books & References

1. R.K.Gupta, Operation Research; Krishna Prakashan Media (P) Ltd., Meerut.
2. R. Panneer Shivam, Operation Research, PHI learning 2008.
3. Hamdy H. Taha, Operation Research-An introduction, Pearson Education, 2003.
4. V.K. Khanna, Total Quality Management", New Age International, 2008.

MMS 601 NUMERICAL METHODS AND ENGINEERING OPTIMIZATION

Course category	:	Basic Sciences & Maths (BSM)
Pre-requisites	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1 , Practical: 2
Number of Credits	:	5
Course Assessment methods	:	Continuous assessment through tutorials, assignments, quizzes, One Minor and one Major Theory & Practical Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. To find the root of a curve using iterative methods
2. To interpolate a curve using Gauss, Newton's interpolation formula.
3. Use the theory of optimization methods and algorithms developed for various types of optimization problems.
4. To apply the mathematical results and numerical techniques of optimization theory to Engineering problems.

Topics Covered

UNIT-I 9

Numerical Methods I: Solution of algebraic and transcendental equations by Bisection, Regula-Falsi and Newton-Raphson methods. Interpolation: Newton's forward and backward interpolation formulae, Lagrange's formula and Newton's divided difference formula.

UNIT-II 9

Numerical Methods II: Solution of system of linear equations by Gauss Jacobi method, Guass-Siedel method, Relaxation method and LU decomposition method, Cholesky method. Numerical differentiation, Numerical Integration: Trapezoidal Rule, Simpson's one-third and three-eight rules.

UNIT-III 9

Classical Optimization Techniques: Introduction, Review of single and multi-variable optimization methods with and without constraints, Non-linear one-dimensional minimization problems, Examples.

UNIT-IV 9

Constrained Optimization Techniques: Introduction, Direct Methods, Cutting plane method, Indirect methods, Convex programming problems, Exterior penalty function method, Examples and problems. Unconstrained optimization techniques: Introduction, Descent methods, Steepest Descent methods Newton's method, Quasi-Newton's method.

Experiments:

1. To implement Regula Falsi method to solve algebraic equations.
2. To implement numerical integration to solve algebraic equations.
3. To implement Gauss-Siedel method for solution of simultaneous equations.
4. To implement Runge-Kutta method of order four to solve differential equations.
5. To implement Euler's method to find solution of differential equations.
6. To find optimum solution to problem parameters.
7. To find derivatives of static displacements and stresses.
8. To write Computer based algorithm and program for solution of Eigen-value problems.
9. Reduction of size of an optimization problem using Reduced basis technique.
10. To find Derivatives of Eigen-values and Eigen vectors.

Books & References

1. S.S.Rao; Engineering Optimization, New Age International.
2. E.J. Haug and J.S. Arora, Applied Optimal Design; Wiley New York.
3. P. Kandasamy, K.Thilagavathy & K.Gunavathy,Numerical Methods, S. chand Publ.

MMS-602 **BUSINESS STATISTICS**

Course category	:	Basic Sciences & Maths (BSM)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes and One Minor tests and One Major Theory Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Use of moments and kurtosis to find the type of curve.
2. Choose a statistical method for solving practical problems
3. To understand the meaning and importance of correlation and regression analysis including both simple and multiple correlation and regression.
4. To have a proper understanding of Statistical applications in Economics and Management.

Topics Covered

UNIT-I

Skewness and Kurtosis: Mean, Mode and Median, Mean deviation, Standard deviation, Coefficient of variation, Skewness, Kurtosis. Types of skewness and kurtosis, measurement of skewness. 9

UNIT-II

Correlation and Regression: Meaning and types of correlation, Karl Pearson and Spearman correlations. Meaning of regression equations, Regression lines and their application. Curve fitting (Straight line and parabola), Least Square method. 9

UNIT-III

Probability: Addition and multiplication theorems of probability, Bay's theorem and its application. Probability distribution and their types, Binomial, Poisson and Normal Distributions and their applications. 9

UNIT-IV

Sampling Theory: Sampling, Types of Sampling, Sampling methods, Formulation of hypothesis; Application of t-test, z-test, chi-square test and F-test. 9

Books & References

1. Beri - Business Statistics (Tata Mc. Graw Hill 2nd edition).
2. Sharma J.K.- Business Statistics (Pearson Education 2nd edition).
3. Gupta C.B., Gupta V. –An Introduction to Statistical methods (Vikas 1995, 23rd edition).
4. Levin Rubin – Statistics for Management (Pearson 2000, New Delhi, 7th edition).

MMS-603 MATHEMATICAL FOUNDATIONS OF COMPUTER SCIENCE

Course category : Basic Sciences & Maths (BSM)
Pre-requisites : NIL
Contact hours/week : Lecture: 3, Tutorial: 1 , Practical: 0
Number of Credits : 4
Course Assessment methods : Continuous assessment through tutorials, assignments, quizzes and Minor and Major Theory & Practical Examination
Course Objectives: :
1. To familiarize students with the mathematics underlying the core areas of Computer Science
2. To develop student's ability to formalize argument using mathematical proofs.

Course Outcomes : The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course

1. Give mathematically precise arguments for their claims .
2. Apply, adapt, and design efficient algorithms to solve computational problems.
3. Use Graphs to formulate and solve computational problems.
4. Use Group theoretic techniques to apply, adapt and design efficient coding schemes.

Topics Covered

UNIT-I

Combinatorics: Review of Permutation and Combination, Mathematical Induction, Pigeon hole Principle, Principle of Inclusion and Exclusion, generating function, Recurrence relations. Solution by method of Generating functions and recurrence relation. 9

UNIT-II

Graph Theory: Introduction, Isomorphism, Sub-graphs, walks, paths and circuits, connected graphs, disconnected graphs and components, Euler graphs, Operations on graphs, more on Euler Graphs, Hamiltonian paths and circuits, The traveling salesman problem, Chromatic number, Chromatic partitioning, Chromatic polynomial. 9

UNIT-III

Group theory: Basic definition and theorems on Groups, subgroups, cyclic groups, normal subgroups, quotient groups. Lagrange's theorem. Ring Theory: Ring, Field, Integral domains - basic definitions and properties. 9

UNIT-IV

Number Theory: Division algorithm, Lame's theorem, linear Diophantine equation, fundamental theorem of arithmetic, prime counting function, statement of prime number theorem, Goldbach conjecture, linear congruences, complete set of residues. Number theoretic functions, sum and number of divisors, totally multiplicative functions, definition and properties of the Dirichlet product, the Mobius inversion formula, the greatest integer function, Euler's phi-function. 9

Textbooks

1. P. Cameron, Combinatorics: Topics, Techniques, Algorithms, Cambridge University Press, 1995.
2. J. H. van Lint, RM Wilson, A Course in Combinatorics, 2nd Ed., Cambridge University Press, 2001.
3. J. A.Bondy and U.S.R.Murty: Graph Theory,Springer, 2008.
4. R.Diestel: Graph Theory,Springer(low price edition) 2000
5. I. N. Herstein, Abstract Algebra, 3rd Ed., Wiley, 1996.
6. D. S. Dummit, RM Foote, Abstract Algebra, John Wiley, 2004.
7. Tom M. Apostol, Introduction to Analytic Number Theory, Springer-Verlag New York.

MMS-604 **APPLIED PROBABILITY AND STATISTICS**

Course category : Basic Sciences & Maths (BSM)
Pre-requisite Subject : NIL
Contact hours/week : Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits : 4
Course Assessment methods : Continuous assessment through tutorials, attendance, home assignments, quizzes and One Minor tests and One Major Theory Examination
Course Outcomes : The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course

1. Use of moments and kurtosis to find the type of curve.
2. Choose a statistical method for solving practical problems
3. To understand the meaning and importance of correlation and regression analysis including both simple and multiple correlation and regression.
4. To have a proper understanding of Statistical applications in Economics and Management.

Topics Covered

UNIT-1

Probability and Distributions: Definition of probability, Addition and Multiplication Laws of probability, Conditional Probability, Baye's Theorem, Binomial Distribution, Poisson's Distribution, Normal Distribution. Problems related to Binomial, Poisson and Normal Distributions. 9

UNIT-II

Statistical Techniques I: Moments, Moment Generating function, Skewness, Types of Skewness, Measurement of Skewness, Kurtosis and its types. Curve fitting: Method of Least Squares, Fitting of Straight lines, Fitting of Parabola of second degree. 9

UNIT-III

Correlation and Regression: Correlation, Correlation coefficient, Spearman's rank correlation coefficient, Regression, Equation of regression lines, linear, non-linear and multiple regression analysis. Relation between Regression Analysis and Correlation Analysis. 9

UNIT-IV

Sampling Theory: Sampling, Tests of Significance, Chi-square test, t-test, Application to Engineering. Time series and fore casting, Statistical quality Control methods, Control charts, $\bar{x}, R, p, np \; and \; C - charts$. 9

Books & References

1. B.S. Grewal; Higher Engineering Mathematics, Khanna Publishers, Delhi.
2. H.K. Dass and Rama Verma; Engineering Mathematics, Vol.III, S. Chand and Co. Ltd., New Delhi.
3. B.V. Ramana; Higher Engineering Mathematics, Tata Mc. Graw Hill Education Pvt. Ltd., New Delhi.

MMS-605 DISCRETE MATHEMATICS

Course category : Basic Sciences & Maths (BSM)
Pre-requisite Subject : NIL
Contact hours/week : Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits : 4
Course Assessment methods : Continuous assessment through tutorials, attendance, home assignments, quizzes and One Minor tests and One Major Theory Examination
Course Outcomes : The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course

1. Use logical notation to define different function such as set, function and relation.
2. Use of basic properties of group theory in computer science.
3. Use of graph theory models to solve problems of connectivity and constraint satisfaction, for example, scheduling.
4. Use of induction hypotheses to prove formulae.

Topics Covered

UNIT-1

Set Theory, Relation and Function: Definition of sets, Countable and uncountable sets, Venn Diagrams, Proofs of some general identities on sets. Definition and types of relation, composition of relation, equivalence relation, partial order relation. Function: Definition, types of function, one to one, into and onto function, inverse function, composition of functions. 9

UNIT-II

Algebraic Structures: Definition, properties and types of algebraic structures, Semi groups, Monoid, Groups, Abelian group, properties of groups, Subgroups, Cyclic groups, Cosets, Factor group, Permutations groups, Normal subgroups, Homomorphism and Isomorphism of groups, examples and standard results. Rings and fields: Definition and Standard results. 9

UNIT-III

Graphs: Simple graph, multigraph, graph terminology, representation of graphs, Bipartite, regular, planar and connected graphs, connected components in a graph, Euler graphs, Hamiltonian path and circuits, graph colouring, chromatic number, chromatic polynomials. Tree: types and definition, rooted tree, properties of trees. 9

UNIT-IV

Combinatorics: Basic counting Technique, Pigeon-hole principle, Discrete Numeric function, Recurrence relations and their solution, Generating function, Solution of recurrence relations by method of generating function. Polya's Counting theorem. 9

Books & References

1. J.P. Tremblay and R. Manohar, Discrete Mathematical Structures with applications to computer science, McGraw Hill 1975.
2. Deo Narsingh, Graph Theory with application to engineering and computer science" by Prentice Hall, Englewood Cliffs, N.J. 1974.
3. V. Krishnamurthy, Combinatorics: Theory and applications, East-west press Pvt. Ltd. New Delhi.

MMS 606 ADVANCED ENGINEERING MATHEMATICS

Course category	:	Basic Sciences & Maths (BSM)
Pre-requisites	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, assignments, quizzes, One Minor and One Major Theory Examination.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course

1. To find out the dimension of vector spaces
2. To describe the differences between finite-difference and finite-element methods for solving PDEs;
3. To solve Elliptical (Laplace/Poisson) PDEs using finite differences;
4. To solve functional using Euler method.

Topics Covered

UNIT-I

Vector spaces and Linear transformation: Vector spaces, subspaces, Linear dependence, Basis and Dimension, Linear transformations, Kernel & images, matrix representation of linear transformation, change of basis, Eigen values and Eigen vectors of linear operators, diagonalization. 9

UNIT-II

Numerical Techniques: Solution of algebraic and transcendental equations using bisection, Regula Falsi and Newton Raphson's method, Numerical solution to linear system, LU factoring decomposition, Cholesky method, Gauss Seidal method, Numerical eigen value problem, Jacobi, Givens method 9

UNIT-III

Calculus of Variation: Functionals, Euler's equation and its generalization. One and several independent variables. Initial value problems. Weierstrass's sufficiency condition for weak and strong minima and maxima 9

UNIT-IV

Numerical Solution of Partial Differential Equations: Classification of partial differential equations of the second order. Laplace equations and its solution by Liebmann's process. Poisson equation. Solution of Parabolic, Eliptic and Hyperbolic Equations. Applications to Engineering. 9

Textbooks

1. K. Hoffman, R Kunze, Linear Algebra, Prentice Hall of India, 1971.
2. I. M. Gelfrand, S. V. Fomin, Calculus of Variation, Dover Publications.
3. M. D. Raisinghania, Advanced Differential Equations, Schand Publishers.
4. P. Kandasamy, K.Thilagavathy & K.Gunavathy, Numerical Methods, S. Chand Publ.

MMS-607 APPLIED COMPUTATIONAL METHODS

Course category : Basic Sciences & Maths (BSM)
Pre-requisite Subject : NIL
Contact hours/week : Lecture: 3, Tutorial: 1, Practical: 2
Number of Credits : 5
Course Assessment methods : Continuous assessment through tutorials, attendance, home assignments, quizzes and One Minor tests and One Major Theory Examination
Course Outcomes : The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. To find the root of a curve using Bisection, Regula falsi Newton's Method.
2. Use of moments and kurtosis to find the type of curve.
3. To interpolate a curve using Gauss, Newton's interpolation formula.
4. To find the derivative of a curve.
5. To find the area of a curve.

Topics Covered

UNIT-I 9

Numerical Methods: Solution of algebraic and Transcendental equations, Bisection method, Method of False position (Regula-Falsi method) and Newton-Raphson method, Solution of linear simultaneous equations; Guass-Siedel method, Crout's method.

UNIT-II 9

Interpolation and Numerical Integration: Interpolation: Finite Differences, Difference operators, Newton's forward and backward interpolation formulae, Lagrange's formula for unequal intervals, Newton's divided difference formula for unequal intervals. Numerical Integration: Trapezoidal Rule, Simpson's one-third and three-eight rules.

UNIT-III 9

Numerical Solution of Ordinary Differential Equations and Difference Equations: Picard's method, Taylor's Series method, Euler's method, Modified Euler's method, Runge-Kutta method of order four. Difference equations and their solutions. Rules for finding the particular integral.

UNIT-IV 9

Statistical Methods and Probability Distributions: Frequency Distributions, mean, mode, median, standard deviation, Moments, Skewness, Kurtosis, Types and measurement of Skewness and Kurtosis. Correlation; Regression and regression lines. Binomial Distribution, Poisson's Distribution, Normal Distribution.

Experiments

1. To implement Regula-Falsi method to find root of algebraic equation.
2. To implement Newton-Raphson method to find root of algebraic equation.
3. To implement Newton's Divided Difference formula to find value of a function at a point.
4. To implement Numerical Integration by using Simpson's one-third rule.
5. To implement numerical solution by using Runge-Kutta method of order four to find solution of differential equation.
6. To implement numerical solution of differential equation by Picard's method.
7. To implement numerical solution of differential equation by using Euler's method.
8. To estimate regression equation from sampled data and evaluate values of standard deviation, regression coefficient.

Books & References

1. B.S. Grewal: Higher Engineering Mathematics; Khanna Publishers.

2. B.V. Ramana: Higher Engineering Mathematics, Tata Mc. Graw Hill Education Pvt. Ltd., New Delhi.
3. H.K. Dass and Rama Verma: Engineering Mathematics; S. Chand Publications.
4. N.P. Bali and Manish Goel: Engineering Mathematics; Laxmi Publications.

MMS-608 OPERATIONS RESEARCH FOR BUSINESS DECISIONS

Course category : Basic Sciences & Maths (BSM)

Pre-requisite Subject : NIL

Contact hours/week : Lecture: 3, Tutorial: 1, Practical: 0

Number of Credits : 4

Course Assessment methods : Continuous assessment through tutorials, attendance, home assignments, quizzes and One Minor tests and One Major Theory Examination

Course Outcomes : The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Identify and develop operational research models from the verbal description of the real system.
2. Be able to build and solve Transportation Models and Assignment Models.
3. Knowledge of formulating mathematical models for quantitative analysis of managerial problems in industry
4. Aware with the basic concepts and tools of game theory and can apply these tools to real-life situations.

Topics Covered

UNIT-1

Linear Programming: Definitions and scope of Operation Research (OR), OR model, Solving OR model. Two variable Linear Programming model and graphical method of solution, Simplex method, Dual Simplex method, Special cases of linear programming. 9

UNIT-II

Transportation Problems: Types of transportation problems, mathematical models, transportation algorithms.Assignment: Allocation and assignment problems and models, processing of job through machines. 9

UNIT-III

Network Techniques: Shortest Path model, minimum spanning tree problem, Max-Flow problem and Min-Cost problem.Project Management: Phases of Project management, guidelines for network construction, CPM and PERT. 9

UNIT-IV

Theory of Games: Rectangular games, Minimax theorem, graphical solution of $2 \times n \ or \ m \times 2$ games, game with mixed strategies, reduction to linear programming model. Elements of Queing model, generalized Poisson queing model. 9

Books & References

1. Wayne L. Winston; Operation Research, Thomson Learning, 2003.
2. R Panneer Seevam; Operation Research, PHI Learning, 2008.
3. V. K. Khanna; Total Quality Management, New Age International, 2008.
4. Hamdy H. Teha; Operation Research-An Introduction, Pearson Education, 2003.

MMS-609 PROBABILISTIC MODELLING

Course category	:	Basic Sciences & Maths (BSM)
Pre-requisites	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical: 2
Number of Credits	:	5
Course Assessment methods	:	Continuous assessment through tutorials, assignments, quizzes and One Minor and One Major Theory & Practical Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course

1. Define, illustrate, and apply the concepts of probability;
2. Analyse and interpret statistical data using appropriate probability distributions
3. Define, illustrate, and apply the concepts of discrete and continuous random variables
4. Understand the concept of Queuing models and apply appropriate queuing model, mainly M/M/1 model.

Topics Covered

UNIT-I

Probability and Probability distributions: Definition, sample space, conditional probability, Baye's theorem, Bernouli's trials, Brief Introduction of Binomial, Poisson and Normal distributions with their applications. 9

UNIT-II

Random Variables: Random Variables, Distribution and Density functions, Moment and Moment generating functions, Independent Random Variables, Marginal and Conditional Distributions, Conditional Expectation. 9

UNIT-III

Queuing Theory: Single and Multiple server Markovian queueing models – customer impatience – Priority queues – M/M/1 queueing system – queueing theory applications. 9

UNIT-IV

Statistical Hypothesis: Concept of Statistical Hypothesis, hypothesis, Procedure of testing the hypothesis, Types of Error, Level of Significance, Degree of freedom. Chi-Square Test, Properties, and Constants of Chi-Square Distribution. Student's t-Distribution, Properties & Applications of t-Distribution. Analysis of Variance, F-Test, Properties & Applications of F-Test. 9

COMPUTER PROGRAMMING LAB

Implement a C programme to calculate Probability, Means, Moments, Variance, Skewness, Standard Deviation, Coefficient of Variation. C program to generate random numbers, to implement various queue operations.

Textbooks

1. V. Rohatgi., An Introduction to probability and Mathematical Statistics, Wiley Eastern Ltd. New Delhi.
2. J.K. Sharma, Operation Research, Laxmi Publications.
3. K. Swaroop, P. K. Gupta, Man Mohan, Operation Research, S. Chand Publishers.