Contents

1.	**Computer Arithmetic And Errors**	1-52
1.1	Introduction	1
1.2	Some Mathematical Preliminaries	1
1.3	Number System	2
1.4	Base Conversion	3
1.5	Binary Arithmetic	11
1.6	Approximations and Errors	13
1.7	Accuracy of Numbers	13
1.8	Errors and their Analysis	16
1.9	Inherent Errors	23
1.10	Rounding off Error	23
1.11	Truncation Error	24
1.12	The General Formula for Errors	26
1.13	Floating Point Arithmetic and Errors	28
1.14	Computer Storage	29
1.15	Concept of Normalized Floating Point	30
1.16	Pitfalls of Floating Point Representation	30
1.17	Error in a Series Approximation	35
1.18	Error in Determinants	36
1.19	Application of Error Formula to the Fundamental Operations of Arithmetics	37
1.20	Order of Approximations	44
1.21	Propagation of Error	45
1.22	Blunders	48
1.23	Numerical Instability	48
1.24	Sensitivity Analysis	49
1.25	Machine Computations	49
1.25	Computer Software	51
2.	**Finite Difference Operators**	53-94
2.1	Introduction	53
2.2	Difference Schemes	53
2.3	Relation between Operators	57
2.4	Fundamental Theorem of Difference Calculus	59
2.5	Method of Separation of Symbols	65
2.6	Effect of an Error in a Tabular Value	69
2.7	Factorial Notation	72
2.8	To Express a given Polynomial into Factorial Notation	73
2.9	Problems Based on Missing Terms	77
2.10	Differences of Zero	80
2.11	Divided Difference	81
2.12	Differences between Divided Difference and Ordinary Difference	82
3.	**Interpolation with Equal Intervals**	95-134
3.1	Introduction	95
3.2	Interpolation	95
3.3	Methods of Interpolation	95
3.4	Finite Difference Calculus	96
3.5	Newton-Gregory Formula for Forward Interpolation with Equal Intervals	96
3.6	Newton-Gregory's Backward Interpolation Formula with Equal Intervals	106
3.7	Some Words Problems based on Newton's Formulae	112
3.8	Central Differences Interpolation Formulae	117
3.9	Stirling's Difference Formula	119

3.10	Bessel's Difference Formula	120
3.11	Everett's Difference Formula	120
3.12	Choice to select the suitable Interpolation Formula	121
4.	**Interpolation with Unequal Intervals**	135-164
4.1	Introduction	135
4.2	Newton's Divided Difference Formula	135
4.3	Lagrange's Interpolation Formula	143
4.4	Hermite's Interpolation Formula	158
4.5	Inverse Interpolation	162
5.	**Numerical Differentiation and Integrations**	165-248
5.1	Introduction	165
5.2	Derivative using Newton's Forward Interpolation Formula	165
5.3	Derivatives using Newton's Backward Difference Formula	166
5.4	Derivatives using Stirling's Formula	167
5.5	Derivatives using Bessel's Central Difference Formula	168
5.6	Derivative using Newton's Divided Difference Formula	169
5.7	Maxima and Minima of Tabulated Function	169
5.8	Error Analysis in Numerical Differentiation	185
5.9	Error in Higher Order Derivatives	186
5.10	Numerical Quadrature	192
5.11	General Quadrature Formula for Equally Spaced Arguments	192
5.12	The Trapezoidal Rule	192
5.13	Simpson's 1/3 Rule	197
5.14	Simpson's 3/8 Rule	198
5.15	Weddle's Rule	207
5.16	Romberg's Method	209
5.17	Newton-Cote's Formula	212
5.18	Properties of Cote's Numbers	213
5.19	Deductions from Newton-Cote's Formula	215
5.20	Gauss's Quadrature Formula	220
5.21	Chebychev's Formula	225
5.22	Higher Order Rules	228
5.23	Numerical evaluation of the Singular Integral	234
5.24	Numerical Double Integration	239
6.	**Numerical Roots of Polynomial and Transcendental Equations in one Variable**	249-336
6.1	Introduction	249
6.2	Properties of the Equations and Its Roots	249
6.3	Methods of Solution	250
6.4	Bisection Method	250
6.5	Iteration Method	261
6.6	Iterative Method for the System of Non-Linear Equations	268
6.7	Regula-Falsi Method (or Method of False Position)	269
6.8	Secant Method	278
6.9	Newton-Raphson's Method	283
6.10	Newton's Formula for finding Special type of Roots	286
6.11	Comparison of Newton's Method and Regula-Falsi Method	287
6.12	Birge-Vieta Method	297
6.13	Complex Roots	306
6.14	Newton's Method for Complex Roots	306
6.15	Muller's Method	308
6.16	Lin-Bairstow's Method	313
6.17	Graeffe's Root Square Method	320
6.18	The Quotient-Difference Method	326
7.	**Numerical Solution of System of Simultaneous Equations**	337-372
7.1	Introduction	337
7.2	System of Simultaneous Linear Equations	337

7.3	Existence of Solution	338
7.4	Solution Methods using Matrices	339
7.5	Solution Methods based on Successive Elimination: Direct Method	340
7.6	Gauss Elimination Method	340
7.7	LU Decomposition Method or Method of Factorization	346
7.8	Jordan's Method	351
7.9	Crout's Method	353
7.10	Iterative Methods	358
7.11	Ill Conditioned and Well Conditioned Equations	368
7.12	Advantages and Disadvantages of Different Methods	370
8.	**Matrix Inversion**	373-404
8.1	Introduction	373
8.2	Gauss-Elimination Method	373
8.3	Gauss-Jordan Method	373
8.4	Triangularisation Method (Doolittle Method)	379
8.5	Crout's Method	386
8.6	Choleski's Method	389
8.7	Escalator Method	395
8.8	Iterative Method	400
8.9	Inversion of Complex Matrices	401
9.	**Eigen Values and Eigen Vectors of a Matrix**	405-462
9.1	Introduction	405
9.2	Relation between Eigenvalues and Eigenvectors	406
9.3	Eigenvalues of Special type of Matrices	407
9.4	Power Method	426
9.5	Inverse Power Method	432
9.6	Rutishauser Method	434
9.7	Jacobi's Method	437
9.8	Given's Method	444
9.9	House Holder's Method	448
9.10	The Cayley-Hamilton Theorem	452
10.	**Initial Value Problems of Ordinary Differential Equations**	463-516
10.1	Introduction	463
10.2	Existence and Uniqueness of Solution of Differential Equation	463
10.3	Euler's Method	465
10.4	Euler's Modified Method	468
10.5	Solution by Taylor Series	473
10.6	Picard's Method of Successive Approximations	477
10.7	Runge-Kutta Method	484
10.8	Simultaneous Differential Equations	492
10.9	Solution of Second Order Differential Equations	493
10.10	Milne's Methods	497
10.11	Adam-Bashforth Method	508
10.12	Error Analysis	511
10.13	Convergence of a Method	513
10.14	Stability Analysis	513
11.	**Initial Value Problems of Partial Differential Equations**	517-550
11.1	Introduction	517
11.2	Difference Quotients	517
11.3	Classification of Partial Differential Equations	518
11.4	Elliptic Equations	519
11.5	Solution of Laplace Equations by LIEBERMANN's Iteration Process	520
11.6	Parabolic Equations	529
11.7	Solution by Forward Difference Method	529
11.8	Solution by Bender-Schmidt's Method	530
11.9	Crank-Nicholson Method	531

11.10	Dufort and Frankel's Method	532
11.11	Iterative Method	532
11.12	Solution of Two-Dimensional Heat Equation: ADE Method	538
11.13	Hyperbolic Equation	540
12.	**Fitting of Curves and Cubic Splines**	551-600
12.1	Introduction	551
12.2	Continuous Frequency Distribution	552
12.3	Graphical Representation	552
12.4	Curve Fitting	554
12.5	Method of Least Squares	554
12.6	Most Plausible Solution of a System of Linear Equations	555
12.7	Method of Curve-Fitting	558
12.8	Fitting of Some Special Curves	558
12.9	Curve Fitting by sum of Exponentials	571
12.10	Spline Function	574
12.11	Regression Analysis	579
12.12	Properties of Regression Coefficients	580
12.13	Angle between two lines of Regression	581
12.14	Fitting a Polynomial Function	588
12.15	Non-linear Regression	590
12.16	Simplified Determination of Regression Analysis	593
12.17	Regression Analysis of Grouped Data	594
12.18	Multiple Linear Regression	594
13.	**Data Approximation of Functions**	601-624
13.1	Introduction	601
13.2	Weirstress Theorem	601
13.3	Norm	601
13.4	Types of Approximations	602
13.5	Use of Orthogonal Functions	606
13.6	Gram-Schmidt Orthogonalizing Process	607
13.7	Legendre and Chebyshev Polynomials	608
13.8	Uniform Approximation	612
13.9	Chebyshev Polynomial Approximations	613
13.10	Lanczos Economization of Power Series for a General Function	614
13.11	Rational Approximation	614
13.12	Approximation with Trigonometric Functions	615
14.	**Difference Equations**	625-654
14.1	Introduction	625
14.2	Difference Equation as a Relation among the value of y_x	625
14.3	Order of Difference Equation	625
14.4	Degree of Difference Equation	626
14.5	Solution of Difference Equation	626
14.6	Linear Difference Equation	628
14.7	Existence and Uniqueness theorem	629
14.8	Solution of the equation $y_{x+1} = Ay_x + B$	629
14.9	Solution as Sequences	634
14.10	Linear Homogeneous equation with Constant Coefficients	637
14.11	Linearly Independent Solution or Fundamental Set of Solutions	638
14.12	General Solution Of Second Order Homogeneous Difference Equation	643
14.13	General Solution Of The Homogeneous Difference Equation Of Order N	644
14.14	Particular Solution Of The Complete Difference Equation	647
14.15	Solution Of Simultaneous Difference Equations	653
	Bibliography	659-660
	Index	661-663