KAKATIYA UNIVERSITY
M.A. / M.Sc. (Mathematics) Previous
(Year Wise Scheme for SDLCE)

PAPER – I
(ALGEBRA)

UNIT – I

Group Action on a Set : The notion of a group action on a set, Isotropy subgroup. Orbits, Application of G-sets to counting.
Sylow theorems : p-groups, Cauchy theorem, the Sylow theorems.
Application of the Sylow theorems : Application to p-groups and the class equation. Further applications

(Text Book : A first course in Abstract Algebra by J.B. Fraleigh, Seventh edition)

UNIT – II

The field of quotients of an integral domain – A review. Rings of polynomials – A review. The evaluation homomorphism, Factorization of polynomials over a field. The division algorithm in F[x], irreducible polynomials, Eisenstein theorem, Uniqueness of factorization in F[x], Prime fields, Application to Factorization in F[x]. Factorization : Unique factorization domains. Euclidian domains : Euclidian domains and Arithmatics in Euclidation domains. Gaussian integers and Norms : Gaussaian integers, Multiplicative norms.

(Text Book : A first course in abstract algebra by J.B. Fraleigh, Seventh edition).

UNIT – III

Algebaic extensions of fields : Adjunction of roots, Algebraic extensions, Algebraically closed fields. Normal and separable extensions : Splitting fields, Normal extensions, Multiple roots, Finite fields, Separable extensions.

(Text Book : Basic Abstract Algebra by P.B. Bhattacharya, S.K. Jain, S.R. Nagpaul, Second edition).

UNIT – IV

Galois theory : Automorphism groups and fields, Fundamental theorem of Galois theory, Fundamental theorem of Algebra. Applications of Galois theory to Classical problems : Roots of Unity and Cylatomic polynomials, Cyclic extensions, Definition of a polynomial solvable by radicals.

(Text Book : Basic abstract algebra by P.B. Bhattacharya, S.K. Jain, S.R. Nagpaul, Second edition, Cambridge University Press).

Reference Books :

1) Topics in Algebra by I.N. Herstein
2) Algebra by S. Lang.

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PAPER – II
(REAL ANALYSIS)

UNIT – I

Metric Spaces :

Definition of Metric space – Limit point – Closed sets – Open sets – Closure of a set – Compact sets – Connected sets – Convergence of sequences in metric space – Subsequence and subsequential limits – Caucly's sequence – Diameter of a set – Definition of complete metric space – Continuous functions in metric spaces – Continuity and compactness – Continuity and connectedness.

(Chapter-2 : Sec. 2.15 – 2.38, Chapter-3 : Sec. 3.1 – 3.2, 3.5 – 3.12,
Chapter-4 : Sec. 4.5 – 4.23).

The Rieman-Stieltjes Integral :

Definition and existence of integral – Necessary and sufficient condition for integrability – Integral as a limit of sum – Integrability of continuous, monotonic discontinuous and composite functions – Properties of the integral – Conversion of Riemann-Stieltjes integral to Riemann integral.

(Chapter-6 : Sec. 6.1 – 6.17).

UNIT – II

Sequences and Series of Functions :

Pointwise and uniform convergence – Cauchy criterion for uniform convergence – Weierstrass Mn-test – Uniform convergence and continuity – Uniform convergence and integration – Uniform convergence and differentiation – Equicontinuous families of functions – Weierstrass (approximation) theorem – Algebra of functions – Uniformly closed algebra – Stone's generalization of the Weierstrass theorem.

(Chapter-7 : Sec. 7.1 – 7.32).

Power Series :

Radius of convergence of power series – Review of summation by parts, absolute convergence, addition and multiplication of series, rearrangements with regard to sequences and series of constants.

Real power series – Continuity and differentiability of power series – Abel's theorem – Inversion in the order of summation – Taylor's theorem – Identical power series.

(Chapter-3 : Sec. 3.38-3.52; Chapter-8 : Sec. 8.1-8.5)

UNIT – III

Functions of Several Variables :

Definition of limit and continuity of real valued functions – Intermediate value theorem – Definition of convex set – Partial derivatives – Existence of directional derivative – Mean value theorem – Necessary and sufficient condition for differentiability – Partial derivatives of higher order – Reversal in the order of derivative – Schwarz's theorem – Young's theorem – Taylor's theorem – A necessary condition for extreme value – Sufficient condition for extreme values – Locally invertible transformation – Jacobian – Definition of linear function – Inverse function theorem – Implicit function theorem – Applications of Implict function theorem for the existence of unique solutions of equations.

(Chapter-12, 13, 14 of Shantinarayana)

UNIT – IV

Improper Integrals :

Definition of convergence at right-end, left-end, both ends, at ∞, at $-\infty$ - A necessary and sufficient condition for convergence of an improper integral – Comparison of two integrals – Convergence of Beta functions – General test for convergence – Convergence of Gamma functions – Absolute convergence – Abel's and Diriehlet's theorems for convergence.

(Chapter-9 of Shantinarayana)

Integrals as Function of a Parameter :

Definite integral as function (ϕ) of a parameter – nature of the function ϕ in relation to continuity and derivability – Inversion of the order of integration –Definition of uniform convergence of improper integral – Tests for uniform convergence – Properties of uniformly convergent improper integrals.

(Chapter-15 of Shantinarayana)

The Gamma Function :

Definition and Properties of Gamma function. Relation between Beta and Gamma function.

(Chapter-8 : Sec. 8.17 – 8.21 of Rudin)

Text Books :

1) A course of Mathematical Analysis by Shantinarayana and Mittal (S. Chand & Company).
2) Principles of Mathematical Analysis by Walter Rudin (Tata McGraw Hill).

References :

1) Mathematical Analysis by T.M. Apostal.
2) Principles of Real Analysis by S.L. Gupta and N.R. Gupta (Pearson education).

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PAPER – III
(DIFFERENTIAL EQUATIONS)

UNIT – I

Second order linear equations – The general solution of homogenous equation – Linear combination of linearly independent solutions – Wronskian of solutions – A necessary and sufficient condition for solutions to be linearly independent – Solution of non-homogenous linear equation by method of variation of parameters.

(Chapter 3, Sec. 15, 19 of Simmons)

Qualitative properties of solutions – Oscillations and the Sturm separation theorem – The sturm comparison theorem. Eigen values, Eigen functions and vibrating string – Sturm – Liouville problem.

(Chapter 4, Sec. 24, 25; Chapter 7, Sec. 40, 43 of Simmons).

Nonlinear equations – Autonomous systems – The phase plane and its phenomena – Types of critical points, Stability, Critical points and stability for linear systems, Stability by liapunov's direct method, simple critical points of nonlinear systems, periodic solutions, the Poincare – Bendixson theorem.

(Chapter 11, Sec. 58, 59, 60, 61, 62, 64 of Simmons).

The existence and uniqueness of solutions, the method of successive approximations and Picards theorem (no proof).

(Chapter 13, Sec. 68, 69 of Simmons).

UNIT – II

Power Series Solutions :

Second order linear equations – Ordinary points – Solution of Legendre, Hermite differential equations – Hermite polynomials – Generating function and Rodrigues formula, orthogonality of Hermite functions – Regular singular points, solution of general second order linear equations by Frobenious method, Solution of Bessel's equation of order 1 & ½, Solution of Gauss Hyper geometric equation, Hyper geometric function.

Some Special Functions of Mathematical Physics :

Legendre polynomials, Properties of Legendre polynomials, Generating functions, Rodrigues formula, Recursion formula, Orthogonality – General solution of Bessel's equation, Properties of Bessel's function, Generating function, Bessel's Integral formula.

(Chapter-5 : Sec. 28, 29, 30, 31; Chapter-8 : Sec. 44, 45, 46, 47, Appendix-C of Simmons).

Contd...

UNIT – III

Formation of First order partial differential equations – Solution of Linear first order partial differential equations (Langrange's method) – Integral surfaces passing through a given curve – Surfaces orthogonal to a given system of surfaces – Compatibility of first order partial different equations – Solutions of Non-linear partial differential equations of first order – Charpit's method – Jacobi's method – Special types of first order equations – Cauchy's method of characteristics.

Second order partial differential equations – Origin – Linear Partial Differential Equations with Constant Coefficients – Methods of Solving Linear Partial Differential Equations – Classification of Second Order Partial Differential equations – Classification of second order partial differential equations – Adjoint operators – Riemann's method.

(Chapter 1, 2 of J.N. Sharma)

UNIT – IV

Derivation of Laplace equation and Poisson's equation – Boundary value problems – Separation of variable method – Laplace equation in cylindrical and spherical coordinates interior and exterior Dirichlet problem for a circle – Interior Dirichlet problem for a sphere – Interior Neumann problem for a circle – Miscellaneous examples.

Solution of Diffusion equation by separation of variables method – Diffusion equation in cylindrical and spherical coordinates – D'Almbert solution of one dimensional wave equation – Separation of Variable Method – Two Dimensional Wave Equation – Green's Function Method of Solving Laplace Equation, Wave equation and diffusion equation.

(Chapter-3, 4, 5 of J.N. Sharma)

Text Book :

1) Differential equations with applications and historical notes, 2nd edition, by George F. Simmons, Tata McGraw Hill.
2) Partial differential equations for engineers and scientists by J.N. Sarma, Kehrsingh (Narosa Publishing House).

References :

1) Elements of Partial Differentiation Equations by I.N. Snedon.
2) Partial Differential Equations by L.C. Evans.
3) Partial Differential Equations by Prasad & Ravindran.

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PAPER – IV
(COMPLEX ANALYSIS)

UNIT – I

Algebra of Complex Numbers
Complex numbers, triangle in equality and its applications, polar and exponential forms. Powers and roots, Regions in the complex plane. Extended complex plane (No question to be set).

Analytical Functions :
Functions of complex variable, Limits and continuity, Differentiability, Cauchy Riemann equations, Some Analytic functions, Harmonic functions.

Elementary Functions :
Exponential functions, Trigonometric functions, Hyperbolic functions, Multivalued functions and its branches, Logarithmic function, Complex exponents, Inverse trigonometric and Hyperbolic functions.
(Chapter 2, 3 of the text book).

UNIT – II

Complex Integration :
Introduction, Contour Integral, Primitives, Cauchy-Goursat theorem when f is (i) Analytic in a domain containing a triangle, (ii) Open convex domain (iii) Open connected domain, Extention of Cauchy-Gourset theorem, Winding number, Cauchy Integral formula, Some consequences of Cauchy Integral formula, Maximum Moduli of functions.

Sequences, Series and Products
Sequences, Series, Convergence, Cauchy condition. Sequences of functions, Uniform convergence, Weierstrass theorem for sequences, Cauchy condition, Series of functions, Uniform convergence, Weierstrass M-test, Weierstrass theorem for series, Infinite products, Absolute convergence, Uniform convergence of infinite product of functions.
(Chapter-4 and 5 of the Text book).

UNIT – III

Series Expansion :
Power series, Uniform convergence of power series, Taylor's series, Parseval's formula, Zeros of analytic functions, Uniqueness theorem, Schwarz Lemma (excluding Reflection principle). Laurent series.

Singularities and Residues :
Classification of singularities Riemann theorem, Residues, Poles, and Zeros, Casorati-Weierstrass theorem, behaviour of functions at infinity, Meromorphic functions, Argument principle, Rouche's theorem, Harwitz theorem, Partial fraction expansions, Mittag-Leffere theorem.
(Chapter 6.1-6.6, 7.1-7.7 of Text book).

UNIT – IV

Sums and Definite Integrals :
Estimation of sums, Definite integrals involving sines and cosines, Improper Integrals, Improper integrals involving sines and cosines, Jordan's inequality, Jordan Lemma. Integration along indented contours.

Conformal Mappings :
Linear transformation, Conformality theorem, Bilinear transformation, Every bilinear transformation maps circles and lines into circles and lines, Inverse of a bilinear transformation is bilinear, Composite of two bilinear transformation is bilinear, Fixed points cross ratio, Invariant bilinear transformation that maps given three points Z_1, Z_2, Z_3 in the extended Z-plane onto distinct points W_1, W_2, W_3 in the extended W-plane especial bilinear transformations.
(Chapter 8.1-8.4, 9.1-9.4 of the Text book).

Text Book : Complex variables, Theory and Applications, 2nd edition, H.S. Kasana, Prentice-Hall of India.

References :

1. Complex Analysis, Sereg Lang, Springer.
2. Complex Analysis, Ahlfors, McGraw Hill.
3. Complex Analysis, Choudhary.

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PAPER – V
(DISCRETE MATHEMATICS)

UNIT – I

Fundamentals of logic – Logical inferences – Methods of proof of an implication – First order logic and other methods of proof – Rules of inference for propositions and quantified propositions – Applications of pigeonhole principle.

Elementary combinatories : Enumerating of permutations and combinations without repetitions, with unlimited repetitions and with constrained repetitions. The principle of inclusion and exclusion – Generating function of sequences – Calculating coefficient of generating functions.

UNIT – II

Relations and Digraphs – Special properties of binary relations – Ordering relations – Lattices and enumerations – Boolean algebras – Boolean functions – Switching mechanisms – Minimization of Boolean functions – Karnaugh's graph method – Applications to digital computer design.

Digraphs – Paths and closures – Directed graphs and adjacency matrices – Warhsall's algorithm of computing the adjacency matrix of the transitive closure of a digraph.

UNIT – III

Graphs – Isomorphism and subgraphs – Trees and their properties – Spanning trees – Directed trees – Binary trees – Planar graphs.

Multigraphs – Euler's formula – Konig's berg seven bridges problem – Euler circuits – Hamiltonian graphs – Grinberg's theorem – Chromatic numbers – The four colour problem.

UNIT – IV

Network flows – Graphs as models of flow of commodities – Flows – Maximal flows and minimal cuts – The max flow – min cut theorem – Construction of a maximal flow – augmenting paths.

Applications of network flows – Matching maximal matching – Complete matching – Matching condition – The Hall's marriage theorem.

Text Book : Discrete mathematics for Computer Scientists and Mathematicians by J.L. Mott, A. Kandle and T.P. Baker.

Reference Books :

1) A text book of Discrete Mathematics by Tremblay and Manohar.
2) Discrete Mathematical Structures by Rao.
3) A first book at Graph theory by John Clark and Derek Allan Hotton.
4) Graph theory by Narsingh Deo.

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Paper – I
MEASURE AND INTEGRATION

UNIT – I

LEBESGUE MEASURE :

Outer measure and its properties, measurable sets and Lebesgue measure, properties of measurable sets, A non-measurable set.

Measurable functions, Littlewood's three principles, Egoroff's theorem, Lusin's theorem.

UNIT – II

LEBESGUE INTEGRAL :

The Labesgue integral of a bounded function over a set of finite measure, the integral of non-negative functions, The General Lebesgue Integral.

UNIT – III

DIFFERENTIATION AND INTEGRATION

Differentiation of monotonic functions, statement of Vitali Lemma, functions of bounded variation, Differentiation of an integral, Absolute continuity.

FOURIER SERIES OF FUNCTIONS OF CLASS L^2 (I) :

Definition of $L^2(I)$ of square-integrable functions, statement of A convergence theorem for series of functions in L^2 (I), the Riesz-Fiiischer theorem, Fourier series of a function in L^2 (I) relative to an orthonormal system, properties of the Fourier coefficients, Bessel's inequality, Parseval's formula, the Riesz-Fisher theorem on Fourier series, the convergence and representation problems for trigonometric series, statement of Riemann-Lebesgue Lemma, An integral representation for the partial sums of a Fourier series, the Riemann Localization theorem, Cesaro summability of Fourier series, Fejer theorem.

UNIT – IV

GENERAL MEASURE AND INTEGRATION :

Measure spaces, completion of a measure, measurable functions on abstract measurable space, integration with respect to a measure μ, General convergence theorems.

Signed measures, Hahn decomposition theorem, The Radon-Nikodym theorem, Lebesgue decomposition theorem.

Scope as in :

1. Real Analysis by H.L. Royden, 3rd edition [Chapter : 3, 4 (except Sec. 5), 5 (except Sec. 5), 11 (except Sec. 7).
2. Mathematical Analysis by T.M. Apostal, 2nd edition [Chapter 10 : sections 10.22, 10.24, 10.25; Chap 11 : Sections : 11.1 – 11.8, 11.10, 11.11, 11.13].

References

1. An Introduction to Measure and Integration - I.K. Rama, Narosa Publishing House.
2. Principles of Mathematical Analysis - Walter Rudin, McGraw Hill.

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Paper – II
TOPOLOGY AND FUNCTIONAL ANALYSIS

UNIT – I

TOPOLOGICAL SPACES :
The definition and some examples, Elementary concepts, open bases and open subbases, weak topologies, the function algebras [C(X, R) and C (X, C)].

COMPACTNESS :
Compact spaces, product of spaces, Tychonoff's theorem.
[Chap : 3 : Sections 16, 17, 18, 19, 20; Chap : 4 : Sec. 21, 22, 23].

UNIT – II
COMPACTNESS FOR METRIC SPACES
T_1-spaces, Hausdorff spaces, completely regular spaces, Normal spaces, connected spaces, the components of a space.
[Chap 4 : Sec : 24; Chap 5 : Sec : 26, 27; Chap 6 : Sec 31, 32].

UNIT – III
BANACH SPACES
The definition and some examples, continuous linear transformations, Hahn-Banach theorem, Natural Imbedding of N in N**, Open mapping theorem, Conjugate of an operator.
[Chap 9 : Sec : 46 to 51].

UNIT – IV
HILBERT SPACES :
The definition and some simple properties, orthogonal complements, orthonormal sets, conjugate space H*.
[Chapt 10 : Sec. 52 – 55].
The adjoint of an operator, self-adjoint operator, Normal and unitary operators, projections, finite dimensional spectral theory, spectral theorem.
[Chap 10 : Sec. 56-59, 62].

Scope as in :
1. Introduction to Topology and Modern Analysis
   G.F. Simmons

References

1. General Topology, J.L. Kelley, Van Nostrand Reinhold Co., N.Y. 1995.
2. Topology, A First Course, James R. Munkres, Prentice-Hall (2000).
3. Functional Analysis, P.K. Jain, O.P. Ahuja, Khalif, Ahmed, New Age International (1997).
4. Introductory Functional Analysis with Applications, E. Kreyszig, John Wiley (1978).

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Paper – III
MATHEMATICAL METHODS

UNIT – I
CALCULUS OF VARIATIONS :

Variational problems with fixed boundaries, the concept of variation and its parameters, Eulers equation, variational problem for functionals depending on derivatives, functional depending on function of several variables, variation problems in parametric form, some applications to problems of mechanics.

Variational problems with moving boundary, functional of the form $I[y(X^1)] = {}_{x1}\int^{x2} F(x, y, y^1)\, dx$, variational problem with movable boundary for a functional depending on two functions one sided variations

(Chap. 1 (1.1 to 1.7), Chap 2 (2.1 to 2.3) of Text book 1).

UNIT – II

Laplace transforms, existence of Laplace transform properties of Laplace transform, The inverse Laplace transforms and its properties, convolution theorem, solution of ordinary differential equations by Laplace transforms, solution of partial differential equations by laplace transforms, Application of Laplace transforms to integral equations.

Fourier transforms, Fourier integral formula, inversion theorem for complex fourier transform, Fourier sine and cosine transform, Inversion, Convolution theorem, Parseval's identity, Finite Fourier Sine and Cosine transforms, Inversion formulae, operational properties convolution, application of Fourier transforms to inversion and boundary value problems.

(Text Book 2).

UNIT – III

Integral equations, differentiation of a function under an integral sign, relation between differential and integral equations, solution of non-homogeneous volterras integral equations by the method of successive substitution and successive approximation, determination of some resolvent kernels, volterra integral equations of first kind.

(Text Book 3).

UNIT – IV

Solution of the Fredholm Integral equation by the method of successive substitution and successive approximation, Reciprocal functions, Volterra's solution of Fredholm equation, Fredholm first theorem, Unique solution of the non-homogeneous Fredholm Integral equation, Symmetric kernels, orthogonality, orthogonality of Fundamental functions, Eigen value of a symmetric kernel, Real characteristic constants, expansion of a symmetric kernel in eigen functions, Green's functions, construction of Green's function. (Text Book 3)

Scope as in :

1. Calculus of variations with applications, A.S. Gupta
2. Integral Transforms, A.R. Vasistha and R.K. Gupta
3. Integral Equations, Shanti Swarup

Reference

1. Operational Mathematics, Churchill, McGraw-Hill.

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Paper – IV(a)
(Elective-I)
OPERATIONS RESEARCH

UNIT – I

Convex functions – Definition of Global and Local minima / maxima mathematical formulation of a LPP – Graphical solution method – Cananical and standard form of a LPP.

Basic – Degenerate – Basic feasible – Optimum basic feasible solutions – Fundamental properties of solutions – reduction of a feasible solution to a basic feasible solution – Improved basic feasible solution. Existence of unbounded solutions – Conditions for optimality.

The Simplex Algorithm Charnes Big M method – Two phase simplex method – Degeneracy and cycling – Inverse of a matrix by simplex method. Duality – Properties and fundamental theorems on Duality – Solution of a LPP by using Duality dual simplex method.

UNIT – II

Transportation problem – Matrix form of T.P. – Special case of LPP – Transportation table – Initial basic feasible solution – North west corner rule – Row minimum – Column minimum – Vogel approximation method of finding initial basic feasible solution – Matrix Minimum Method – Loops in a T.P. – Transportation Algorithm or finding optimal solution – Degeneracy in T.P. – Unbalanced T.P.

Assignment and routing problems – Hangarian method of finding optimal assignment problems – Sequencing problems – Johnson's method of solving the problems – Problems with a job and two and more than two machines.

Integer programming – All & mixed integer programming problems – Gomory's All LPP method – Gomory's mixed integer programming.

UNIT – III

Games & Strategies : Two person zero-sum games. The maximin and minimax principle. Games without saddle points – Mixed strategies – Solution of 2 x 2 rectangular games. Graphical method, Dominance property.

Queueing Theory : Queueing system – Characteristics of Queueing system – Study state solution of (M/M/I). ($\propto$ /FIFO) queuing system – Poisson queues with exponential service times – Traffic. Intensity ratio – Average queue length average waiting time of an arrival.

UNIT – IV

Inventory control – Definition of various costs involved in inventory control – Demand, Lead time – Stock replacement – EOQ concept of selective control techniques. Problems of EOQ without and with shortages.

Basic concepts – Constraints in Networks – Consumption of Network time calculation networks critical path method (CPM). PERT, PERT calculations. Negative float and Negative slack – Advantages of Network (PERT / CPM)

Text Book : Operations Research by Kanti Swarup P.K. Gupta and Manmohan.
Reference Book : Operations Research by Handy A. Taha, Printice Hall of India.

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Paper – V(a)
(Elective-II)

NUMERICAL ANALYSIS

UNIT – I

Algebraic and transcendental equations ; Introduction, errors in Numerical computations, Iteration methods, Bisection method, Regula Falsi method, Newton-Raphson method.

Simultaneous Equations :

Introduction, simultaneous equation, Basic substitution, Gauss elimination method, Gauss-Jordan elimination method, Calculation of inverse of matrix, Crout's method, Iterative methods, Gauss Jordan Iterative method, Gauss-seidal method, Relaxation method.

UNIT – II

Finite Differences

Introduction, Difference operators, other difference operators, Error propagation in a difference table, summation of series.

Interpolation

Introduction, Newton's Interpolation formulae, central difference interpolation formulae, divided differences, Newtons divided difference formula, Inverse Interpolation.

UNIT – III

Numerical differentiation and Integration

Derivatives using Newton's forward difference formula, derivatives using Newton's backward difference formula, derivatives using Central difference formula, Maxima and Minima of the Interpolating polynomials, Numerical Integration.

Difference Equation :

Introduction, Basic definition formula of difference equation, Linear differenc equation.

UNIT – IV

Numerical Solution of Ordinary Differential Equations :

Introduction, Taylor's series method, Euler's Method, Ranga-Kutta methods, Predictor-Correctors method, Milne's method, Adams-Bashforth method.

Numerical solution of partial differential equations :

Introduction, classification of partial differential equations of second order, finite difference approximation to derivatives, Laplace equation, Poisson's equation, One-dimensional heat equation, One-dimensional wave equation.

Scope as in :

1. Numerical methods, S. Arumugan, A. Thangaperdi Isaae, A. Somasundaram

References :

1. An Introduction to Numerical Analysis, Atkinson K.E. Second edition, John-Wiley.