No. 1 Price : Rs. 5/-

University of Poona

Syllabi for the Three-Year Integrated B.Sc. Degree Course

"85 Pattern" (Non-Semester)

T.Y.B.Sc. Mathematics (From 1987-88)

Paper I : Set Theory, Logic and Metric Spaces

SECTION I

1. **Theory of sets and functions :** Product sets, relations, functions, Types of functions, Characteristic function, Choice function, Inverse function, Images and inverse images of subsets.
2. **Real numbers :** Dedekind cuts. Cantor-Dedekind Theorem, Bounds.
3. **Cardinal numbers :** Equivalent sets, Denumerable sets, The continum, Cardinal numbers, Cardinal arithmatic, Inequalities in cardinal numbers. Cantor's theorem, Schroeder Bernstein theorem, Continuum hypothesis.
4. **Algebra of propositions :** Statements, Conjuction, Disjunction, Negation, Conditional, Biconditional Propositions and truth tables-Tautologies and contradictions. Logical equivalence. Algebra of propositions. Logical implication--Logically true and logically equivalent statements.
5. **Quantifiers :** Propositional functions and truth sets Universal quantifiers; Existential quantifier, Negation of proposition containing quantifiers. Counter examples, propositional functions containing more than one variable.

6. **Logical reasoning :** Arguments; Arguments and Venn diagrams. Arguments and propositions. Arguments and quantifiers. Conditional statements and variations.

Recommended Books

1. Set Theory and Related Topics—Seymour Lipschutz, Schaum's Outline Series.
2. Introduction to real variable theory—S. C. Saxena and S. M. Shah, Prentice Hall of India Pvt. Ltd.

Reference Books

1. Set Theory and Logic—R. R. Stoll, Eurasia Publ. House.
2. Naive Set Theory—P. R. Halmos, Von Nostrand.

SECTION II

1. Metric Spaces. Limits in metric spaces.
2. Continuous functions on metric spaces—Open sets, closed sets.
3. Connected metric spaces.
4. Bounded and totally bounded sets.
5. Complete metric spaces—Contraction mappings.
6. Compact metric spaces. Continuous functions on compact metric spaces. Uniform continuity.

Recommended Book

(1) Methods of Real Analysis—R. R. Goldberg, Oxford & IBH Publi. (Chapters : 4, 5 and 6).

Reference Books

(2) Metric Spaces E. T. Copson, Cambridge University Press Publication.

(3) Introduction to Topology and Modern Analysis—G . F Simmons, McGraw Hill Book Company..

Paper II : Real Analysis

SECTION I

1. **Reimann Integration :** Definition of the Reimann integral. Existance of the Reimann integral. Properties of the Reimann integral.
2. Mean value theorems for definite integrals. First mean value theorem. Second mean value theorem of Bonnet and Weierstrass. Fundamental Theorem of Calculus.
3. **Improper integrals:** Improper integrals of the First kind and Second kind. Necessary and sufficient conditions for convergence. Absolute convergence. Test of convergence.
4. **Beta and Gamma Integrals :** Convergence of beta and gamma integrals. Properties of beta and gamma functions. Relation between beta and gamma functions.

SECTION II

1. **Series of real numbers :** Convergence and divergence of Series of with non-negative terms. Alternatinr series. Conditional convergence and absolute convergence. Rearrangements of series. Test for absolute convergence. Series whose terms from a non-increasing sequence. Summation by parts.
2. **Sequences and Series of functions :** Pointwise convergence of sequences of functions. Uniform convergeoce of sequences of functions. Consequences of uniform convergence. Convergence and uniform convergence of series of functions. Integration and differentiation of series of functions.
3. **Fourier Series :** Fourier Series and Fourier coefficient, Dirichlet's conditions of convergence, Fourier series for even and odd functions. Sine and Cosine series in half range. Fourier series in an arbitrary interval.

Recommended Books

1. Methods of Real Analysis—R. R. Goldberg, Oxford and IBH Publi. Co.
2. Mathematical Analysis (Real)–S. K. Chatterjea, Oxford and IBH Publi. Co.

Reference Books

1. Introduction to real variable theory--S. C. Saxena and S. M. Shah, Prentice Hall of India Pvt. Ltd.
2. A course of Mathematical Analysis--Shanti Narayan, S. Chand and Company.
3. Mathematical Analysis S. C. Malik, Wiley Eastern Ltd.
4. Principles of Mathematical Analysis- Walter Rudin, Mac Graw Hill.
5. गणिती–विश्लेषणाची मूलतत्त्वे (मराठी भाषांतर)—अनुवादक म. रा. राईलकर, कॉन्टिनेन्टल प्रकाशन.

Paper III : Problem Course (Based on Paper I and II).

Paper IV : Algebra

SECTION I

(Abstract Algebra)

1. Normal subgroups, Conjugate groups, Quotient groups, Commutator subgroups.
2. Group of permutations.
3. Homomorphism and Isomorphism.
4. Integral domain, Subrings, Ideals and Quotient ring
5. Ring homomorphism, Field of Quotients.
6. Polynomial rings.

Recommended Books

1. Introduction to Abstract Algebra—Fraleigh G. B.
2. Topic in Algebra--I. N. Herstein, Blaisdell Publishing Company.
3. Modern Algebra- Frank Ayers, SCHAUM.
4. University Algebra—Gopal Krishnan.
5. Abstract Algebra- A. R. Singal.

SECTION II

(Linear Algebra)

1. **Vector Spaces :** Vector spaces and Subspaces, Linear span, Quotient space, Linear dependence, Basis and dimension of finite dimensional space. Co-ordinates, Existence theorem, replacement theorem, invariance of number of elements in a basis, Extension theorem, theorems on basis and dimensions.

2. **Linear transformations :** Range and null space, Rank and nullity. Vector space L (V, W), Algebra of L. T., Invertible L. T., Singular and non-Signular L. T., Representation of L. T. by matrices, Raw and Column spaces of a matrix. Rank of matrix and theorems on ranks, matrices and system of linear equations.

3. Matrix, polynomials, characteristic and minimal polynomials, eigen values, eigen vectors of L. T., similarity and diagonalization.

Recommended Books

1. Linear Algebra—David C. Murdoch, John Willy.
2. Linear Algebra—Hoffman and Kunze.
3. Linear Algebra—Seymour Lipschutz (SCHAUM).

Paper V : Dynamics and Differential Equations

SECTION I

(Dynamics)

1. **Kinematics of particles and rigid bodies :**

(14 Periods, 12 Marks)

1.1. Velocity and acceleration of a particle along a curve.
1.2. Motion in a plane-radial and transverse components.
1.3. Relative velocity and acceleration.
1.4. Kinematics of rigid body rotating about a fixed point.

1.5. Vector angular velocity.

1.6 General motion of a rigid body.

1.7. General rigid body motion as a screw motion.

1.8. Composition of angular velocities.

1.9. Moving axes.

1.10. Instantaneous axis of rotation and instantaneous centre of rotation.

2. Newton's laws of motion : (14 Periods, 12 Marks)

2.1. Mass, momentum, force, Newton's laws of motion, Equation of motion.

2.2. Work, energy and power. Energy equation.

2.3. Conservative force, potential energy,

2.4. Impulsive forces.

2.5. Rectilinear particle motion :
(i) Uniformaly accelerated
(ii) Resisted motion
(iii) Motion under gravity
(iv) Simple harmonic motion
(v) Damped and forced vibrations
(vi) Force as a function of time.

2.6. Elastic strings and springs.

3. Particle dynamics : (12 Periods, 10 Marks)

3.1. Problems in two and three dimensions.

3.2. Projectile motion under gravity.

3.3. Constrained particle motion.

3.4. Angular momentum of a particle.
(Def. Principle of angular momentum, conservation theorem.)

4. **Orbital motion :** (10 Periods, 8 Marks)
   - 4.1. Motion of particle under Central force.
   - 4.2 Use of Pedal Co-ordinates and equation.
   - 4.3. Kepler's laws of planetary motion and Newton's law of gravitation.
   - 4.4. Elliptic harmonic motion.

5. **Motion of a System of particles :**
   - 5.1. Linear momentum and Equation of motion.
   - 5.2. Angular momentum and principle of angular momentum.
   - 5.3. Moving Origins.
   - 5.4. Implusive forces.
   - 5.5. Elastic impact.

Recommended Books

The Text-book of Dynamics—F. Chorlton,
Chapters 2, 3, 4 (except art. 4, 5), 5 (except art. 5. 5).

Reference Books

Principles of Mechanics—Synge and Griffith.
The theory of classical dynamics—J. B. Griffith.

SECTION II

(Differential Equations)

1. **Ordinary differential equations in three variables :**
   - 1.1. Surface and curves in three dimensions.
   - 1.2. Simultaneous differential equations of first order and of first degree.
   - 1.3. Methods of solution of
     $$\frac{dx}{P} = \frac{dy}{Q} = \frac{dz}{R}.$$
   - 1.4. Orthogonal trajectories of a system of curves on a surface.
   - 1.5. Pfaffian differential forms and equation, theorems.
   - 1.6. Solution of Pfaffian differential equations in three variables and geometrical meaning of integral curves.

2. Partial differential equations of first order :

2.1. Partial differential equation.
2.2. Origin of first order particle differential equation.
2.3. Cauchy's problem.
2.4. Linear equations of first order.
2.5. Integral surfaces passing through a given curve.
2.6. Surfaces orthogonal to given system of surfaces.
2.7. Non-linear partial differential equations.
2.8. Compatible solutions.
2.9. Charpit's method.
2.10. Special types of first order equations.
2.11. Solution satisfying given conditions.
2.12. Jacobiis method.

3. Partial differential equations of order two and of higher orders :

3.1. Origin of the equations.
3.2. Linear partial differential equation with constant co-efficient :
(*a*) reducible and irreducible.
(*b*) homogeneous and non-homogeneous.
3.3. Non-linear equations of 2nd order, Monge's method.

Book Recommended

1. Elementary partial differential equation by Sneddon Ch. 1 (except art. 7,8), 2 (except art. 14)
3 (except art. 3, 6, 7, 8, 10)

Reference Books

1. Differential equations –Frank Ayers (Schaum)
2. Ordinary and partial differential equations by Raisinghavia and Agrawal.

Paper VI : Problem Course (Based on Paper IV and V).

Paper VII (a) : Linear Programming and Numerical Analysis

SECTION I

1. Basic L. P.—Problems. Linear equations and inequations. Graphical solutions.
2. **Transportation** : Stepping stone method. MODI and Vogel's approximation. Degeneracy and its resolutions. Assignment problems. Koening's theorem.
3. Simplex method. Algebraic solution. Degeneracy and its resolution. Duality. Dual problems and their interpretations. Solution by Simplex.
4. **Theory of games** : Two person-zero-sun games. Pure strategy and addle point. Minimax theorem (without proof) mxz and 2zxn games. Mixed strategies. Relation of the thepry of games to L P.

Recommended Books

1. Linear Programming—Loomba
   Tata Mc-Graw Hill Publ. Comp.
2. Operations Research—Gupa and Hira.

Reference Books

1. Linear Programming—S. Vajda, Chapman and Hall.
2. Linear Programming and Theory of Games—P. P. Sharma
3. Mathematical Programming—Reinfield and Vogel
4. Optimization Methods—Mittal
5. Linear Programming—S. I. Gass, Mc-Graw Hill.
6. Operations Research—Kanti Swarup et al, Sultan Chand and Co.

SECTION II

5. Numerical methods vis-a-vis algebraic and analytic methods. Needs for numerical methods, concept of error.
6. Solution of equations. Location of roots. Sturm's theorem (without proof). Harner's method. Interative method. Newton Raphson method. $x \phi(x)$ interation.
7. Linear system. Gauss elimination method. Gauss-Seidel interation. Matrix inversion for linear equations.
8. Fitting of Polynomials. Collocation and least square methods.
9. Interpolation Operators E. and their relations. Newton's forward and backward formula. Lagrange's formulae.
10. Numerical integration. Simpson's rules. Cote's formula and Cote's numbers.
11. Differential equations of the first order and Runge-Kutta method.

Recommended Books

1. Theory of Equations – J. V. Uspensky. Tata Mc Graw Hill Publ.
2. Finite Difference and Numerical Analysis H. C. Saxena. S. Chand and Comp. Ltd.
3. Calculus of Finite Differences & Numerical Analysis P. P. Gupta, G. S. Malik, Krishna Prakashan Mandir.
4. Numerical Mathematical Analysis J. B. Scarborough, Oxford and IBH Publi. Comp.

Reference Books

1. Examples in Finite Differences Calculus and Probability—H Freeman, Cambridge University Press, 1947.
2. Theory and Problems of Numerical Analysis- F. Sheild, McGraw Hill Schaum Series, 1968.
3. Introduction to Numerical Analysis- C. E. Froberg. Addison Wesley, 1970.
4. Numerical Analysis, Volume II- C. D. Childyal et al. Macmillan Publi., 1986.
5. Theory of Equations W. S. Bernside & A. W. Panton, S. Chand and Company Ltd.

Paper VII (b) : Differential Geometry

SECTION I

1. **Curves in Space :** Tangent line, principal normal and binormal at a point on a space curve. Osculating plane, normal plane and rectifying plane at a point on a curve. Torsion, curvature, radius of curvature. Serret–Frenet formulae. The circle of curvature. Properties of the locus of the centre of curvature. The sphere of curvature, Properties of the locus of centre of spherical curvature. Spherical indicatrix. Involutes and evolutes. The curvature and torsion of the evolute. Bertrand curve. Fundamental theorem for space curves. Congruent curves. Intrinsic equations.

2. **Developable Surfaces :** Parametric representation of surfaces. Tangent plane, Normal line at a point Envelopes and Characteristic relating to one parameter family of surfaces. Edge of regression. Envelopes and characteristic relating to one parameter family of planes and two parameter family of planes.

   Developable surfaces. General differential equation of a developable surface. Developables associated with a space curve. Properties of associated developables. The parameter family of surfaces. Characteristic points.

2. **Ruled Surfaces :** Criterion of a skew surface. Tangent plane to a surface. Tangent surface. Central point. Line of striction.

SECTION II

4. **Curves on Surfaces :** Curvilinear coordinates. First and second order fundamental magnitudes. Fundamental forms. Direction coefficients. Derivative of the unit surface normal. Curvature of normal section. Meunier's theorem. Theorems on Gaussian Curvature.

5. **Line of Curvature :** Principal directions. Lines of curvature. Principal curvature. Euler's theorem. Joachimsthal's theorem. Rodrigue's theorem. First and Second curvature. Minimal surfaces, Dupin's theorem, Dupin's indicatrix.

6. **Curves traced on a surface :** Conjugate directions and parametric curves, conjugate directions and Dupin's indicatrix. Asymptotic lines.

7. **Geodesics :** Geodesic differential equations. External property. Normal property. Analytical property. Geodesics on a surface revolution. Clariut's theorem. Geodesics on developables. Geodesics on central co-conicoids. Curvature and torsion of a geodesic, Bonnet's formula.

Recommended Book

1. Three Dimensional Differential Geometry—Bansi Lal, Atma Ram & Sons.

Reference Books

1. An Introduction to Differential Geometry- T. J. Willmore, Oxford Publi.
2. Differential Geometry--Weatherburn.
3. Differential Geometry—J. Struik.

Paper VII (e) : Number Theory and Combinatories

SECTION I

(Number Theory)

1. **Divisibility :** Revision of Fundamental theorem on Arithmetic, god of numbers as their linear combination and Euclidean algorithm. Expressing numbers in any base. There are infinitely many prime numbers Fermat primes. Mersenne primes. There are arbitrarily large gaps in the series of primes. There are infinitely many primes of the form $4n - 3$, $6n + 5$, $4n + 1$. The statement of Dirichlet's theorem on primes in an arithmetic progression.

2. **Congruences :** Revision of congruences and residues complete and reduced, residue system. Euler's theorem and Fermat's theorem as its corollary. Wilson's theorem. Solutions of congruences.
Congruences of degree. 1. Chinese remainder theorem.

3. **Arithmetic functions :** The Euler's totient function $\phi(n)$ $\phi(n)$ is multiplicative. Formula for $\phi(n)$ $\sum_{d|n} \phi(d) = n$. The greatest integer function. The arithmetic functions $T(n)$, (n), $K(n)$. Perfect numbers if $f(n)$ is multiplicative, then so is $F(n) = f(d)$. Mobious inversion formula.

4. **Power residues :** n^{th} power residue. Exponent. Primitive root mod m. There are $\phi(p-1)$ primitive roots modulo a prime p, statement for composite modulus. Number of solution of $x^n = a \pmod{p}$.

5. **Diophantine equations :** (1) $ax + by = c$
(2) $x^2 + y^2 = z^2$
(3) $x^3 + y^3 = z^2$.
Format's conjecture.

Recommended Book

1. An Introduction to theory of numbers—I. Niven and R. S. Zukerman.

Additional Books for Reference

1. Number Theory—J. Hunter.
2. Number Theory—G. H. Hardy and E. M. Wright.
3. Higher Arithmetic—H. Davenport.

SECTION II

(Combinatorics)

1. **The pigeonhole principle :**
The pigeonhole principle and its strong form. Ramsey's theorem without proof and simple applications.

2. **Basic counting principles :**

The addition principle, the multiplication principle, Permutations and combinations of sets. Permutations and combinations of multisets. Generating permutations, inversions in permutations. Generating r-combinations.

3. **The binomial coefficients :**

Pascal's formula, binomial theorem. Identitiers. Unimodal property of binomial coefficients. The multinomial theorem. Newton's binomial theorem.

4. **The inclusion -exclusion principle :**

Combinations with repetition, Derangements, Formula for Euler's totient function. Derangements, permutations with forbidden positions.

5. **Recurrence relations :** Tyc Fibonacci sequence, Linear homogeneous recurrence relations with constant coefficients the case of distinct roots and the case of repeated roots, Iteration and induction, Difference tables.

6. **Generating functions :** Linear recurrence relations. Exponential generating function.

1. Introductory combinatorics—Richard R. Brualdi Publ., North-Holland, 1977 (Chapters 2 to 7).
2. *Combinatories :* Theory and Applications—V. Krishnamurthy. Affiliated East-West Press Pvt. Ltd., 1985 (Chapter 1, excluding 2, 6).

Paper VII (d) : Lattices and Graphs

SECTION 1

1. **Posets :** Definition examples, chains, unordered posets, covering relations. [*Lemma* If p, be a finite poset then $a \leq b$ if $a = b$ or there exists a finite sequence $x_1\ x_2 \ldots\ldots x_n$ such that $x_1 = a$, $x_n = b$, x_i is covered by x_{i+1}]. Hasse diagram. Isomorphism of posets partial order on finitesets, Bounded posets. Principle of duality.

2. **Lattice :** Definition as a poset and definition as an algebra, equivalence of the two definitions. Hasse diagrams of Lattices. Optimum and planar lattices. Principle of dulity. Maximal and minimal element. Ascending (A.C.C.) and Descending (D.C.C.) chain dual statement. Examples of posets with A.C.C., D.C. upto isomorphism of n elements and chains. Isomorphism of chains. Every chain is a lattice.

   Inequalities in lattices, Modular Distributive Lattices" Nonmodular lattices n_5. Modular but nondistributive lattices m_5, sublattices. Inter-section of sublattices is a sublattice Ideals. Principal Ideals. Every sublattice of modular (distributive) lattice is modular (distributive). Complement of a lattice. In a distributive lattice if complement exists, it is unique. Median characteristics of modular and distributive lattices in terms of medians.

3. **Boolean Lattice :** De Morgan's rules, joining of irreducible elements, Atoms, dual atoms Every element of a finite Boolean Algebra can be expressed as a join of atoms. From Boolean Ring to Boolean Algebra and vice-versa Applications of Boolean Algebra to electrical circuits.

SECTION II

(Graph Theory)

1. Graphs, Definitions, Examples. Degree of vertices, Adjancy, Incidence, Handshaking Lemma
2. Isomorphism, Subgroups.
3. Walks, Paths, Circuits.
4. Connected and disconnected graphs, components.
5. Eulerian and Hamiltonian graphs, Chinese postman and Travelling salesman problems.
6. Trees, properties of trees, fundamental circuits trees, roots and binary trees, counting trees, Polya's theorem.
7. Cutsets, cut vertices connectivity, Network flows separability, Fundamental circuits and cutsets.

8. Matrix representation of graphs—Incidence Matrix, Adjancy matrix.
9. Directed graph--Definition, Examples, Digraphs and Binary Relations. Directed Trees.

Recommended Books

1. Graph Theory with Applications to Engineering—Narsing Deo.
2. A first step in Graph Theory--Raghunathan, Ninik and Sholapurkar (Nirali Prakashan).

Reference Books

1. Introduction to Graph Theory—Robin Wilson.
2. Graph Theory--Harary.

VII (e) : Algebraic Geometry

(From June 89)

SECTION I

Introduction of plane cure. Homogenous Co-ordinate· Projective plane. Line at infinity.

Equation of Curve reducible irreducible Curve Components. Alline algebraic Curve Resuctanle. Alline and projective transformations.

SECTION II

Simple points and Singular points. Intersection multiplicity of a line with a curve order of a curve. The holar equations. Bezour's theory and its applications. Cubics Raliend functio) Points of inflexion. The Modulus of a non-singular cubic.

Recommended Book

1 Elements of the Theory of Algebraic Curve—A Silenbey, Addison Wessley Co. (Chapters 1–10).

Additional Books

1. Rudiments of Algebraic Geometry—W. E. Jonner, Oxford University Press.
2. Methods of Algebraic Geometry—Hodge and Pedoe, (Vol 1–3).

Paper VIII (a) : Computer Programming

SECTION I

1. Number Systems : Decimal, Binary and B.C.D. Conversions from one system into another.
2. Introduction, Types of Computers : (1) Analog, Computers, (2) Digital Computers. Generations, Components of a Computer, Compiler, Input-Output devices. Computer Hardwares and Softwares. Programming languages, Machine languages.
3. Flow-charting : Conversions and illustrations.
4. Pascal :
   (i) Characters in PASCAL. Syntax diagrams.
   (ii) Constants and scalar variables.
   (iii) Arithmetic Expressions :
   Arithmetic Operators and Modes for Expressions, Integer Expressions, Real Expressions, Hierarchy of Operations in Expressions, Assignment Statements. Defining Variable. Some problems due to Rounding of Real Numbers, Mixed Model Expressions, Library Functions, Program Preparation Preliminaries.
   (iv) Input–Output Statements : Input Statements, Output Statements, Printing Titles.
   (v) Simple Computer Programs.
   (vi) Conditional Statements : Relational Operators, Compound Statement in PASCAL, Conditional statements.
   (vii) Implementing Loops in Programs :
   The *repeat* Loop, The *while* Loop, The *for* loop.
   (viii) Defining and Manipulating Arrays :
   Use of Multiple Subscripts, Syntax rules for Arrays. Reading and Writing Arrays, *for* loops with Arrays.
   (ix) Boolean Expressions and More Control Statements : Boolean Constants, Variables and Expressions Precedence Rules for Boolean Operators, Decision Table Conversion to Pascal, The *case* statement, Unconditional Branching in Pascal.

(x) A statistical Data Processing Programs.

(xi) Functions and Procedures :
Declaring and Using Functions, Syntax Rules for Function Declaration, Procedures, Block structure in Pascal.

5. **Basic**

Introduction to BASIC : Numbers, Strings, Variables Operators and Formulas (Expressions), Hierarchy - operations, Use of Parentheses, Special Rules Concern-Formulas, Assigning Values, The LET statement, Reading Input-The Input statement, Printing output-The Print statement, The END statement, Writting Complete BASIC Programmes, Programme Comments-The REM Statement, Transferring Control The GO-TO Statement, Repetitions Programme Execution.

SECTION II

6. **Pascal :**

(1) Some Numerical Programmes : Operations with Polynomials, Finding Roots of a Non-linear Equations, Integration of Functions.

(2) Processing Character Strings : The Character Data Type, Manipulating Strings of characters, Searching in a String, A string Processing Example, Packing and Unpacking Character strings.

(3) Enumerated Scalar Types, Sets and Stackis, Enumera') Scalar Data Type, Set Data Structure and its Uses, A stack. Simulations of a Stack, Applications of Stack.

(4) Records and Files : Records and their applications, Variant Records, Files, Creating a Sequential File. Searching a Sequential File, Updating a sequential File, Merging Two sequential Files, Text Files.

(5) Pointer Data Type and its Applications List data Structure, Manipulation of Linearly Linked List. Circular and doubly Linked Lists, A Doubly Linked Circular List, Binary Trees.

(6) Recursion In Pascal : Recursive Functions and Procedures, Recursion versus Iteration, Some Recursion Algorithms. Tree Traversal Algorithms.

7. Basic

Relational Operators, Conditional Branching—The IF–THEN Statement, Multiple Branching. The ON–GO–TO Statement, The FOR–TO Statement, The STOP Statement, Closing a Loop NEXT Statement, Nested Loops.

Recommended Books

1. Computer Programming in Pascal—V. Rajaraman, Prentice Hall of India Pvt. Ltd., New Delhi (Revised Edition).
2. Programming With BASIC—Vteib S. Gitterued, McGraw Hill Book Company.

Reference Books

1. User Manual and Report, Springer Verlag—Jonsen K. and N. Wirth, New York, 1974.
2. BASIC A First Course—Robert G. Thompson, CBS Publishers and Distributers, 485, Jain Bhavan Bholanath Nagar, Shahdra, Delhi–110032 (India).
3. FORTRAN and Engineering—Aatya Prakash Garg, Applications Nemchand & Bros. Roorkee (U.P.).
4. Basic Programming—Jwnwbt & Jyrth.
5. Basic—Atcock D.
6. Principles of Computer Programming—Rajaraman,

Paper VIII (b) : Theory of Integration

SECTION I

Riemann Stielties Integral Definition of monotonic functions, properties of monotonic. Partitions of real omterma; Functions of bounded variations, Total variation. Continuous functions of bounded variation.

Definition of Riemann Stieltjes integral on bounded and closed real interval. Linearity properties of R–S integrals, Integration by parts in R. S. integration, change of variable

R–S integral. Reduction to Riemann integral, Step functions as integrators. Reduction of R–S integral to a finite sum, Euler's Summation formula. Upper and lower R–S integrals, characterization of R–S integral in terms of Riemann's condition, R–S integrators of bounded variation. Necessary and sufficient conditions for the existence of R–S integral. First and Second meanvalue theorems for R–S integrals, properties of the integral as a function of the interval. R–S integrals depending on a parameter, Differentiation under R–S integral sign. Interchanging the order of integration. Improper R–S integrals, infinite R–S integrals, Tests for convergence of infinite integrals, Infinite series and infinite integrals.

Recommended Book

Mathematical Analysis—T. M. Apostol.
(S 8.1 to 8.5. SS 9.1 to 9.20, 14.1 to 14.4.).

SECTION II

(Lebesgue Integrals)

Lengths of open and closed subsets in the real line. Inner and outer measures and measurable sets in the real line. Properties of measurable sets. Real valued measurable functions : Sequences of measurable functions. Definition existence of the Lebesgue integral for bounded functions, characterization of Lebesgue functions, sufficient conditions for Lebesgue integrability, properties of Lebesgue integrals. The Lebesgue integral for unbounded functions, Lebesgue integral on measurable subsets of a bounded or closed real interval and their properties, Lebesgue dominated convergence theorem, Fatou's Lemma, The space of square Lebesgue integrable functions, The Schwerz's inequality, the Minkowski inequality, completeness of the space of square, Lebesgue integrable functions, The set of continuous functions on (a, b) is dense in $\mathcal{L}^2$ (a, b). The Lebesgue integral on ($-\infty$, ∞) and the plane. Fubini's Theorem (Statement only).

Methods of Real Analysis—R. R. Goldberg, Oxford IBH Publ (Chapter XI)

References

(1) Principles of Mathematical Analysis—Walter Rudin, McGraw–Hill.
(2) गणिती विश्लेषणाची मूलतत्वे—वॉल्टर रुदिन (अनुवादक : म. रा. राईलकर, कॉन्टिनेन्टल प्रकाशन).
(3) Intro. to Real Variable Theory—S. C. Saxena and S. M. Shah, Prentice–Hall of India.
(4) Mathematical Analysis—S. C. Malick, Wiley Eastern.
(5) Lebesgue Measure and Integration—P. K. Jain and V. P. Gupta, Wiley–Eastern.

Paper VIII (e) : Probability Distributions

SECTION I

1. **Discrete probability distributions :**
   - (i) Discrete random variable.
   - (ii) Distribution function.
   - (iii) Univariate and bivariate distribution.
   - (iv) Probability generating function.
   - (v) Characteristic function.
   - (vi) Conditional and marginal distributions.
   - (vii) Expectation and conditional expectation.
   - (viii) Tchebycheff's theorem.
   - (ix) Theorems on expectations.
   - (x) Law of large numbers.
   - (xi) Raw and central moments.
   - (xii) M.G.F., C.G.F., M.G.C. of $AX + B$, $X + Y$.
   - (xiii) Correlation coefficient and independence of random variables.
   - (xiv) Effect of change of origin and scale.
2. **Standard Discrete distributions :** Binomial Poisson, uniform distributions.
3. **Univariate and Bivariate continuous type of distributions :**
   - (i) Distribution function, density function characteristic function.
   - (ii) Conditional and marginal distributions.

(iii) Expectation and conditional expectation, theorems of expectation.
(iv) Raw and central moments, M.G.F/C.G.F.
(v) P.D.F. of $AX + B$, $X^2 e^x$, $\log X$.
(vi) Mode, median, quartiles, dispersion.
(vii) Correlation coefficients and independence.
(viii) Joint Probability law.

SECTION II

4. Standard continuous distributions :

(i) Normal, uniform, exponential, Beta and Gamma, Cauchy.
(ii) Relation between variates of first and second kind beta variates.
(iii) Nature of probability curve.
(iv) Distribution of $\frac{x}{y}$, $\frac{x}{x+y}$ where x and y are independent variates.
(v) Relation between distribution finites of binomial and beta distribution of first kind.

5. Various distributions related to normal distribution :

(i) X^2, t, F, z distributions.
(ii) Bivariate normal distribution.
(iii) Sampling distributions of $\bar{X}$ and S^2 for normal population.
(iv) Normal approximation of t.
(v) Interrelation between X^2, t, F distributions.

Recommended Books

(1) Fundamentals of Mathematical Statistics—Gupta and Kapoor.
(2) Mathematical Statistics—Kapoor and Saxena.

Reference Books

(1) Mathematical Statistics—Hogg and Kraig.
(2) Mathematical Statistics—Hoel.

Paper VIII (d) : Astronomy

SECTION I

1. **Spherical Trigonometry** : Angle of interaction to two great circles, Secondaries, Relation between arc of a small circle and arc of a great circle. Spherical triangle, Polar triangle, Cosine Rule, Sine Rule, Cotangent Rule, Supplemental cosine rule, sine–cosine rule. Sine Cosine, tangent of angle and half angle as functions of sides and vice–versa.
2. Napier's, Delambre's anologies. Right angled spherical triangles, Napiers's rule of circular parts in right angled spherical trangle.
3. **Astronomy** : Colestical sphere and different systems of colestical co–ordinater. Rising and setting conditions of a star. Motion of the sun. Siderial time, Rate of change of Zenith distance and azimuth.
4. Twilight, Atmospheric refraction, refraction in zenith distance. Cassini's hypothesis, Differential equation for refraction, Simpson's and Braddley's hypotheses. Refraction in any direction, Refraction in right ascension and declination.

SECTION II

1. Kepler'r Laws of planetary motion, true anomaly eccentric anomaly, mean anomaly: Kepler's equation, Expressions of anomalies in terms of each other.
2. Siderial time, Mean time, conversion of time, equation of time, Seasons, Synodic period, Geocentric and Holio Centric conjuctions.
3. Geocentric motion of a planet. Elongation of a planet, phases of moon. Brightness of the planet.
4. Procession and nutation procession in R. A. declination, Nutation in R. A. and declination, Independent day numbers.

Recommended Books

(1) Spherical Trigonometry—Todhunter, Revised by Gorakh Prasad.

(2) Spherical Astronomy—Gorakh Prasad, Publisher Pothishala, Allahabad.

Reference Book

Spherical Astronomy—Smart W. H.

Paper IX : Problem Course

Based on Paper VII-VIII.

(From June 1989)

Complex Analysis- VIII (e) :

SECTION I

Complex number field. Bilinear Transformations. Topological properties of Complex number field. Infinite Series, Power series.

SECTION II

Complex differentiation, Cauchy-Riemann equations, Riemann- Stieltjes integration of Complex functions. Cauchy's theorem with proof for ston shaped regions. Cauchy's integral formula. Taylor's theorem and Proof, Open mapping theorem Conformal mapping.

Recommended Book

(1) Complex Analysis—J. V. Deshpande, Tata McGraw Hill.

Additional Books

(1) Functions of One Complex Variable- J. B. Conway.

(2) Complex Variables H. Silverman

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