B.Sc. PART-III

MATHEMATICS

PAPER I : ANALYSIS

Max. Marks : 100 — Lectures to be delivered : 120 periods
Pass Marks : 35% — Time Allowed : 3 hours

INSTRUCTIONS FOR PAPER SETTER

The question paper will consist of five sections : A, B, C, D and E. Sections A, B, C, D will have two questions from the respective sections of the syllabus. Section E will have only one question, which will consist of 8 or 10 objective/very short answer type parts covering the whole syllabus. All the questions from Sections A, B, C, D and E will carry equal marks.

INSTRUCTIONS FOR THE CANDIDATES

Candidates are required to attempt one question each from the sections A,B,C and D of the question paper and the entire section E. All questions carry equal marks.

SECTION-A

Riemann integral. Integrability of continuous and monotonic functions. The fundamental theorem of integral calculus. Mean value theorem of integral calculus.

SECTION-B

Improper integrals and their convergence, Comparison tests, Abel's and Dirichlet's tests. Frullani's integral. Integral as a function of a parameter. Continuity, derivability and integrability of an integral of a function of a parameter, Beta and Gamma functions.

Double and triple integrals. Dirichlet's integrals. Change of order of integration in double integrals.

Fourier series. Fourier expansions of piecewise monotonic functions.

SECTION-C

Sequences and series of functions, pointwise and uniform convergence, Cauchy's criterion for uniform convergence, Weierstrass M-test, Abel's and Dirichlet's tests for uniform convergence, uniform convergence and continuity, uniform convergence and Riemann-integration, uniform convergence and differentiation, Weierstrass approximation theorem.

SECTION-D

Complex numbers as ordered pairs. Geometric representation of Complex numbers. Stereographic projection.

Continuity and differentiability of Complex functions. Analytic functions, Cauchy-Riemann equations. Harmonic functions.

Elementary functions. Mapping by elementary functions.

Mobius transformations. Fixed points. Cross ratio. Inverse points and critical mappings. An analytic functions as Conformal mappings. Examples.

REFERENCES

1. T. M. Apostol, *Mathematical Analysis*, Norosa Publishing House, New Delhi, 1985.
2. R. R. Goldberg, *Real Analysis*, Oxford & IBH Publishing Co., New Delhi, 1970.
3. D. Somasundaram and B. Choudhary, *A First Course in Mathematical Analysis,* Narosa Publishing House, New Delhi, 1997.
4. Shanti Narayan. S *Course of Mathematical Analysis*, S.Chand & Co., New Delhi.
5. P. K. Jain and S. K. Kaushikk, *An Introduction to Real Analysis*, S. Chand & Co., New Delhi, 2000.
6. R.V. Churchill & J.W. Brown, *Complex Variables and Applications*, 5th Edition, McGraw Hill, New York, 1990.
7. Shanti Narayan, *Theory of Functions of a Complex Variable*, S. Chand & Co., New Delhi.

PAPER II : ABSTRACT ALGEBRA

Max. Marks : 100 — Lectures to be delivered : 120 periods
Pass Marks : 35% — Time Allowed : 3 hours

INSTRUCTIONS FOR PAPER SETTER

The question paper will consist of five sections : A, B, C, D and E. Sections A, B, C, D will have two questions from the respective sections of the syllabus. Section E will have only one question, which will consist of 8 or 10 objective/very short answer type parts covering the whole syllabus. All the questions from Sections A, B, C, D and E will carry equal marks.

INSTRUCTIONS FOR THE CANDIDATES

Candidates are required to attempt one question each from the sections A, B, C and D of the question paper and the entire section E. All questions carry equal marks.

SECTION-A

Groups, Subgroups, Cyclic groups, Coset decomposition, Legrange's Theorem and its consequences–Fermat's and Euler's Theorems. Normal Subgroup, Quotient groups. Homomorphism and Isomorphism. The Fundamental Theorem of Homomorphism. Theorems of Isomorphism. Automorphisms, inner automorphism. Automorphism groups.

Conjugacy relation, normalizer. Counting principle and the class equation of a finite group. Centre for Group of prime-order. Cauchy's theorem. Permutation groups. The alternating groups A_n. Cayley's Theorem.

SECTION-B

Rings, Subrings, Integral domains and fields. Characteristic of ring and a field. Ideals, Quotient Rings. Ring homomorphism. Field of quotients of an integral domain. Polynomial rings, Polynomials over the rational field. The Eisentein's Criterion. Polynomial rings over commutative rings. Principle Ideal Domain (PID), Euclidean Domain, Unique Factorization Domain (UFD), R Unique Factorization Domain implies so is R[x].

SECTION-C

Definition and examples of vector spaces. Subspaces. Sum and direct sum of subspaces. Linear dependence, independence and their basic properties.

Basis. Finitely generated vector spaces. Existence theorem for bases. Invariance of the number of elements of a basis set. Dimension. Existence of complementary subspace of a finite dimensional vector space. Dimension of sums of subspaces. Quotient space and its dimension.

SECTION-D

Linear transformation. Algebra of Linear Transformations. Rank— Nullity Theorem. Isomorphism and Isomorphic Spaces. Matrix of a Linear Transformation. Change of basis. Linear Operators Eigenvalues and Eigenvectors of a Linear Operator. Characteristic polynomial and characteristic equation of a linear operation. Cayley Hamilton Theorem. Algebraic and geometric multiplicity of an eigenvalue, diagonalization. Minimal polynomial of a Linear Operator and of a matrix, Nature of eigenvalues of some special types of matrices. Real quadratic forms.

REFERENCES

1 I.N. Herstein, *Topics of Algebra*, Wiley Eastern Ltd., New Delhi, 1975.
2. Shanti Narayan, *A Text Book of Modern Abstract Algebra*, S.Chand & Co., New Delhi.
3. K. Hoffman and R. Kunze, *Linear Algebra*, 2nd Edition, Prentice Hall, Englewood Cliffs, New Jersey, 1971.
4. S.K. Jain, A. Gunawardena & P.B. Bhattacharya, *Basic Linear Algebra with MATLAB*, Key College Publishing (Springer-Verlag) 2001.
5. Vivek Sahai and Vikas Bist, Narosa Publishing House, 1997.
6. D.S. Malik, J.N. Morderson and M.K. Sen, *Fundamentals of Abstract Algebra*, McGraw-Hill, International Edition, 1997.

ANY ONE OF THE FOLLOWINGS :

PAPER III : OPTIONAL

Opt. I : Discrete Mathematics

Max. Marks : 100 Lectures to be delivered : 120 periods
Pass Marks : 35% Time Allowed : 3 hours

INSTRUCTIONS FOR PAPER SETTER

The question paper will consist of five sections : A, B, C, D and E. Sections A, B, C, D will have two questions from the respective sections of the syllabus. Section E will have only one question, which will consist of 8 or 10 objective/ very short answer type parts covering the whole syllabus. All the questions from Sections A, B, C, D and E will carry equal marks.

INSTRUCTIONS FOR THE CANDIDATES

Candidates are required to attempt one question each from the sections A, B, C and D of the question paper and the entire section E. All questions carry equal marks.

SECTION-A

Sets and propositions-Cardinality, Mathematical induction, Principle of inclusion and exclusion.

Computability and Formal Languages-Ordered Sets. Languages. Phrase Structure Grammars. Types of Grammars. Types of Grammars and Languages.

Permutation. Combinations and Discrete Probability. Relations and Function-Binary Relations. Equivalence Relations and Partitions. Partial Order Relations and Lattices. Chains and Antichains. Pigeon Hole Principle

SECTION-B

Graphs and Planar Graphs-Basic Terminology. Multigraphs. Weighted Graphs. Paths and Circuits Shortest paths. Eulerian Paths and Circuits. Travelling Salesman Problem. Planar Graphs. Trees. Finite State Machines-Equivalent Machines. Finite State Machines as Language Recognizers.

SECTION-C

Analysis of Algorithms-Time Complexity. Complexity of Problems. Discrete Numeric Functions and Generating Functions. Recurrence Relations and Recursive Algorithms Linear Recurrence Relations with Constant Coefficients. Homogeneous Solutions. Particular Solution. Total Solution. Solution by the Method of Generating Functions.

SECTION-D

Brief review of Groups and Rings. Boolean AIgebras-Lattices and Algebraic Structures. Duality. Distributive and Complemented Lattices. Boolean Lattices and Boolean Algebras. Boolean Functions and Expressions. Prepositional Calculus. Design and Implementation of Digital Networks. Switching Circuits.

RECOMMENDED TEXT

1. C. L. Liu, *Elements of Discrete Mathematics* (Second Edition), McGraw Hill, International Edition, Computer Science Series, 1986.

REFERENCES

1. J. Glen Brookshear, *Computer Science: An Overview*, Addition-Wesley.
2. Stanley B. Lippyman, Josee Lojoie, *C Primer* (3rd Edition), Addison-Wesley.

PAPER III : OPTIONAL

Opt. II : Number Theory

Max. Marks : 100 Lectures to be delivered : 120 periods
Pass Marks : 35% Time Allowed : 3 hours

INSTRUCTIONS FOR PAPER SETTER

The question paper will consist of five sections : A, B, C, D and E. Sections A, B, C, D will have two questions from the respective sections of the syllabus. Section E will have only one question, which will consist of 8 or 10 objective/very short answer type parts covering the whole syllabus. All the questions from Sections A, B, C, D and E will carry equal marks.

INSTRUCTIONS FOR THE CANDIDATES

Candidates are required to attempt one question each from the sections A, B, C and D of the question paper and the entire section E. All questions carry equal marks.

SECTION-A

Divisibility, Greatest common divisor, Fundamental Theorem of arithmetic, congruences, residue classes and reduced residue classes, Euler-Fermat theorem, Wilsons's theorem, Linear congruences, Chinese Remainder theorem.

SECTION-B

An Application to cryptography, primitive roots, indices, quadratic residues, Legendre Symbol, Euler's criterion, Gauss Lemma., Quadratic reciprocity Law, Jacobi Symbol. Arithmetic functions (n), d(n), (n), (n), Mobius inversion Formula.

SECTION-C

The Diophantine equations . Farey sequences, continued Fractions, Approximation of reals by rationals, Pell's equations. The Partitions. Minkowski's theorem in Geometry of Numbers and its application to Diophantine inequalities.

SECTION-D

Binary quadratic forms, Hermite's theorem on minima of positive definite quadratic forms and its applications to representation of a number as a sum of two, three and four squares. Order of magnitude and average order of arithmetical functions, Euler summation formula, Abel's Identity, Elementary results on distribution of primes.

REFERENCES

1. David M.Burton, *Elementary Number Theory*, 3rd Edition WmC, Brown Publishers (scope as in Chapters I-II).
2. Niven & Zuckeman, *Introduction to Number Theory*, Wiley Eastern (Scope as in Chapters 1-7).
3. T.N. Apostal, *Introduction to Analytic Number Theory*, Springer Verlag. (Scope as in Chapters 1-7).
4. Hardy & Wright, *Number Theory*, Oxford Univ. Press (Scope as in Chapter 19).
5. H. Davertport, *Higher Arithmetic*, Camb. Uni. Press.
6. E. Landau, *Elementary Number Theory*, Chelsea, Part-III.

PAPER III : OPTIONAL

Opt. III : Theory of Optimization

Max. Marks : 100 Lectures to be delivered : 120 periods
Pass Marks : 35% Time Allowed : 3 hours

INSTRUCTIONS FOR PAPER SETTER

The question paper will consist of five sections : A, B, C, D and E. Sections A, B, C, D will have two questions from the respective sections of the syllabus. Section E will have only one question, which will consist of 8 or 10 objective/very short answer type parts covering the whole syllabus. All the questions from Sections A, B, C, D and E will carry equal marks.

INSTRUCTIONS FOR THE CANDIDATES

Candidates are required to attempt one question each from the sections A,B,C and D of the question paper and the entire section E. All questions carry equal marks.

SECTION-A

Notion of probability: Random experiment, sample space, axiom of probability, elementary properties of probability, equally likely outcome problems.

Random Variables : Concept, cumulative distribution function, discrete and continuous random variables, expectations, mean, variance, moment generating function.

Discrete random variable : Bernoulli random variable, binomial random variable, generic random variable, Poisson random variable.

Continuous random variables: Uniform random variable, exponential random variable, Gamma random variable, normal random variable.

SECTION-B

Conditional probability and conditional expectations, Bayes theorem, independence, computing expectation by conditioning; some applications–a list model, a random graph, Paly's urn model.

Bivariate random variables: Joint distribution joint and conditional distributions, the correlation coefficient.

Functions of random variable: Sum of random variables. The law of large numbers and central limit theorem, the approximation of distributions.

Uncertainty, information and entropy, conditional entropy, solution of certain logical problems by calculating information.

SECTION-C

Optimization :

The linear programming problem. Problem formulation, Linear programming in matrix notation. Graphical solution of linear programming problems. Some basis properties of convex sets, convex functions and concave functions. Theory and application of the simplex method of a linear programming problem. Charne's M-Technique. The two phase method.

SECTION-D

Principle of duality in linear programming problem. Fundamental duality theorem. Simple problems. The transportation and Assignment problems.

REFERENCES

1. S. M. Ross, *Introduction to Probability Models* (Sixth edition) Academic Press, 1997.
2. I. Blake, *An Introduction to Applied Probability*, John Wiley & Sons, 1979.
3. J. Pitman, *Probability*, Narosa, 1993.
4. A. M. Yagolam and I.M. Yagolam, *Probability and Information*, Hindustan Publishing Corporation, Delhi, 1983.
5. Mokhtar S.Bazara, John J.Jarvis and Hanif D.Shirali, *Linear Programming and Network flows*, John-Wiley & Sons., 1990.
6. G. Hadley, *Linear Programming*, Narosa Publishing House, 1995.
7. S. I. Gass, *Linear Programming: Methods and Applications* (Fourth edition), McGraw-Hill, New York 1975.
8. Kanti Swaroop, P.K.Gupta and Man Mohan, *Operations Research*, Sultan Chand & Sons, New Delhi 1998.
9. Hamdy A.Taha, *Operations Research*, Prentice Hall of India, Pvt. Ltd., 1997.
10. LINDO Systems Products

    (Visit Website http:/www.lindo.com.productsf.htme)

    (i) LINDO (the linear programming solver), For more details about the above product one has to click on its name.

    (ii) Optimization Modelling with LINDO (5th edition) by Linus Schrage.

    Other references available on the Related books page.

PAPER III : OPTIONAL

Numerical Analysis

Max. Marks : 100 Lectures to be delivered : 120 periods

Pass Marks : 35% Time Allowed : 3 hours

INSTRUCTIONS FOR PAPER SETTER

The question paper will consist of five sections : A, B, C, D and E. Sections A, B, C, D will have two questions from the respective sections of the syllabus. Section E will have only one question, which will consist of 8 or 10 objective/very short answer type parts covering the whole syllabus. All the questions from Sections A, B, C, D and E will carry equal marks. Use of scientific non-programmable calculator is allowed.

INSTRUCTIONS FOR THE CANDIDATES

Candidates are required to attempt one question each from the sections A, B, C and D of the question paper and the entire section E. All questions carry equal marks.

SECTION-A

Interpolation : Lagrange and Hermite Interpolation, Divided Differences, Difference Schemes, Interpolation Formulas using Difference.

Approximation, Polynomial Approximation using Least Square Polynomial Approximation, Polynomial Approximation using Orthogonal Polynomials. Approximation with Trigonometric Functions, Exponential Functions, Chebychev Polynomials, Rational Functions.

Numerical Differentiation. Numerical Quadrature : Newton-Cote's Formulas, Gauss Quadrature Formulas, Chebychev's Formulas.

SECTION-B

Solution of Equation : Bisection, Secant, Regula Falsi, Newton's Methods, Roots of Polynomials.

Linear Equations : Direct Methods for Solving Systems of Linear Equations (Gauss Elimination, LU Decomposition, cholesky Decomposition), Iterative Methods (Jacobi, Gauss-Seidel. Relaxation Methods).

The Algebraic Eigenvalue problem; Jacobi's Method. Givens Method, Householder's Method. Power Method, QR Method, Lanczos' Method.

SECTION-C

Ordinary Differential Equations : Euler Method, Single-step Methods, Runge-Kutta's Method, Multi-step Methods, Milne-Simpson Method, Methods Based on Numerical Integration. Methods Based on Numerical Differentiation, Boundary Value Problems. Eigenvalue Problems.

SECTION-D

Monte Carlo Methods :

Random number generation, congruential generators, statistical test of pseudo-random numbers.

Random variate generation, inverse transform method, composition method, acceptance-rejection method, generation of exponential, normal variates, Binomial and Poisson variates.

Monte-Carlo Integration, hit or miss Monte-Carlo integration, Monte-Carlo Integration for improper integrals, error analysis for Monte-Carlo integration.

REFERENCES

1. C.E. Froberg, *Introduction to Numerical Analysis,* (Second Edition), Addison-Wesley, 1979.
2. James B. Scarborough, *Numerical Mathematical Analysis*, Oxford and IBH Publishing Co. Pvt. Ltd., 1966.
3. M.K. Jain, S.R.K. Iyengar, R.K. Jain, *Numerical Methods Problems and Solution,* New Age International (P) Ltd., 1996.
4. R.Y. Rubistein, *Simulation and the Monte Carlo Methods,* John Wiley, 1981.
5. D.J. Yakowitz, *Computational Probability and Simulation,* Addison-Wesley, 1977.
6. S.S. Sastry, *Numerical Methods*, PHI.