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## ELECTIVE COURSE

### B.Sc. III

PAPER 01 - ANALYSIS

PAPER 02 - ABSTRACT ALGEBRA

PAPER 03 - OPTIONAL

(I) PRINCIPLES OF COMPUTER SCIENCE

(II) DISCRETE MATHEMATICS

(III) APPLICATION OF MATHEMATICS IN FINANCE AND INSURANCE

(IV) PROGRAMMING IN C AND NUMERICAL ANALYSIS (THEORY AND PRACTICAL)

(V) MATHEMATICS MODELLING.

  
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## MATHEMATICS

There shall be three theory papers. Two compulsory and one optional. Each paper carrying 50 marks is divided into five units and each unit carry equal marks.

### PAPER - I (Paper Code-0898)

#### ANALYSIS

##### REAL ANALYSIS

**UNIT-I** Series of arbitrary terms. Convergence, divergence and Oscillation. Abel's and Dirichlet's test. Multiplication of series. Double series. Partial derivation and differentiability of real-valued functions of two variables. Schwarz and Young's theorem. Implicit function theorem. Fourier series. Fourier expansion of piecewise monotonic functions.

**UNIT-II** Riemann integral. Integrability of continuous and monotonic functions. The fundamental theorem of integral calculus. Mean value theorems of integral calculus.

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.

##### COMPLEX ANALYSIS

**UNIT-III** 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. Fixedpoints. Cross ratio. Inverse points and critical mappings. Conformal mappings.

##### METRIC SPACES

**UNIT-IV** Definition and examples of metric spaces. Neighbourhoods, Limit points, Interior points, Open and closed sets, Closure and interior. Boundary points, Sub-space of a metric space. Cauchy sequences, Completeness, Cantor's intersection theorem. Contraction principle, Construction of real numbers as the completion of the incomplete metric space of rationals. Real numbers as a complete ordered field.

**UNIT-V** Dense subsets. Baire Category theorem. Separable, second countable and first countable spaces. Continuous functions, Extension theorem. Uniform continuity, Isometry and homeomorphism. Equivalent metrics. Compactness, Sequential compactness. Totally bounded spaces. Finite intersection property. Continuous functions and compact sets, Connectedness, Components, Continuous functions and connected sets.



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## REFERENCES :

1. T.M. Apostol, Mathematical Analysis, Narosa Publishing House, New Delhi, 198
2. R.R. Goldberg, Real Analysis, Oxford & IBH publishing Co., New Delhi, 1970.
3. S. Lang, Undergraduate Analysis, Springer-Verlag, New York, 1983.
4. D. Somasundaram and B. Choudhary, A First Course in Mathematical Analysis, Narosa Publishing House, New Delhi, 1997.
5. Shanti Narayan, A Course of Mathematical Analysis, S. Chand & Co. New Delhi.
6. P.K. Jain and S.K. Kaushik, An introduction to Real Analysis, S. Chand & Co., New Delhi, 2000.
7. R.v. Churchill & J.W. Brown, Complex Variables and Applications, 5<sup>th</sup> Edition, McGraw-Hill, New York, 1990.
8. MarkJ. Ablowitz & A.S.Fokas, Complex Variables : Introduction and Applications, Cambridge University Press, South Asian Edition, 1998.
9. Shanti Narayan, Theory of Functions of a Complex Variable, S. Chand & Co., New Delhi.
10. E.t. Copson, Metric Spaces, Cambridge University Press, 1968.
11. P.K. Jain and K. Ahmad, Metric Spaces, Narosa Publishing House, New Delhi, 1996.
12. G.F. Simmons, Inroductin to Topology and Modern Analysis, McGraw-Hill, 1963.



  
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**PART - II (Paper Code-0899)**  
**ABSTRACT ALGEBRA**

**UNIT-I** Group-Automorphisms, inner automorphism. Automorphism groups and their computations, Conjugacy relation, Normaliser, Counting principle and the class equation of a finite group. Center for Group of prime-order, Abelianizing of a group and its universal property. Sylow's theorems, Sylow subgroup, Structure theorem for finite Abelian groups.

**UNIT-II** Ring theory-Ring homomorphism. Ideals and Quotient Rings. Field of Quotients of an Integral Domain, Euclidean Rings, Polynomial Rings, Polynomials over the Rational Field. The Eisenstien Criterion, Polynomial Rings over Commutative Rings, Unique factorization domain.  $R$  unique factorisation domain implies so is  $R[x_1, x_2, \dots, x_n]$  Modules, Submodules, Quotient modules, Homomorphism and Isomorphism theorems.

**UNIT-III** Definition and examples of vector spaces. Subspaces. Sum and direct sum of subspaces, Linear span. Linear dependence, independence and their basic properties.

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

**UNIT-IV** Linear transformations and their representation as matrices. The Algebra of linear transformations. The rank nullity theorem. Change of basis. Dual space. Bidual space and natural isomorphism. Adjoint of a linear transformation. Eigenvalues and eigenvectors of a linear transformation. Diagonalisation. Annihilator of a subspace. Bilinear, Quadratic and Hermitian forms.

**UNIT-V** Inner Product Spaces-Cauchy-Schwarz inequality. Orthogonal vectors. Orthogonal Complements. Orthonormal sets and bases. Bessel's inequality for finite dimensional spaces. Gram-Schmidt Orthogonalization process.



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## REFERENCES :

1. I.N. Herstein, Topics in Algebra, Wiley Eastern Ltd., New Delhi, 1975.
2. N. Jacobson, Basic Algebra, Vols. I & II. W.H. Freeman, 1980 (also published by Hindustan Publishing Company).
3. Shanti Narayan, A Text Book of Modern Abstract Algebra, S.Chand & Co. New Delhi.
4. K.B. Datta, Matrix and Linear Algebra, Prentice Hall of India Pvt. Ltd., New Delhi, 2000.
5. P.B. Bhattacharya, S.K. Jain and S.R. Nagpal, Basic Abstract Algebra (2<sup>nd</sup> Edition) Cambridge University Press, Indian Edition, 1997.
6. K. Hoffman and R. Kunze, Linear Algebra, 2<sup>nd</sup> Edition, Prentice Hall. Englewood Cliffs, New Jersey, 1971.
7. S.K. Jain, A. Gunawardena & P.B. Bhattacharya, Basic Linear Algebra with MATLAB. Key College Publishing (Springer-Verlag) 2001.
8. S. Kumaresan, Linear Algebra. A Geometric Approach, Prentice-Hall of India, 2000.
9. Vivek Sahai and Vikas Bist, Algebra, Narosa Publishing House, 1997.
10. I.S. Luther and I.B.S. Passi, Algebra, Vol. I-Groups, Vol. II-Rings. Narosa Publishing House (Vol. I-1996, Vol. II-1999)
11. D.S. Malik, J.N. Mordeson, and M.K. Sen, Fundamentals of Abstract Algebra, McGraw-Hill International Edition, 1997.



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**PAPER - III - (OPTIONAL)**

**(I) PRINCIPLES OF COMPUTER SCIENCE (Paper Code-0900)**

**UNIT-I Data Storage** - Storage of bits. Main Memory. Mass Storage. Coding Information of Storage. The Binary System. Storing integers, storing fractions, communication errors. **Data Manipulation** - The Central Processing Unit. The Stored-Program Concept. Programme Execution. Other Architectures. Arithmetic/Logic Instructions. Computer-Peripheral Communication.

**UNIT-II Operating System and Networks** - The Evolution of Operating System. Operating System Architecture. Coordinating the Machine's Activities. Handling Competition Among Process. Networks, Networks Protocol. **Software Engineering** - The Software Engineering Discipline. The Software Life Cycle. Modularity. Development Tools and Techniques. Documentation. Software Ownership and Liability.

**UNIT-III Algorithms** - The Concept of an Algorithm, Algorithm Representation. Algorithm

Discovery. Iterative Structures. Recursive Structures. Efficiency and Correctness.

(Algorithms to be implemented in C ).

**Programming Languages** - Historical Perspective. Traditional Programming Concepts, Program Units. Language Implementation. Parallel Computing. Declarative Computing.

**UNIT-IV Data Structures** - Arrays. Lists. Stacks. Queues. Trees. Customised Data Types. Object Oriented Programming.

**File Structure** - Sequential Files. Text Files. Indexed Files. Hashed Files. The Role of The Operating System.

**Database Structure** - General Issues. The Layered Approach to Database Implementation. The Relational Model. Object-Oriented Database. Maintaining Database Integrity. E-R models.

**UNIT-V Artificial Intelligence** - Some Philosophical Issues. Image Analysis. Reasoning. Control System Activities. Using Heuristics. Artificial Neural Networks. Application of Artificial Intelligence.

**Theory of Computation** - Turing Machines. Computable functions. A Non computable Function. Complexity and its Measures. Problem Classification.

**REFERENCES :**

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

  
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**PAPER - III - (OPTIONAL)**

**(II) DISCRETE MATHEMATICS (Paper Code-0901)**

**UNIT-I Sets and Propositions** - Cardinality, Mathematical Induction, Principle of Inclusion and exclusion,

Computability and Formal Languages - Ordered Sets, Languages, Phrase Structure Grammars, Types of Grammars and Languages, Permutations, Combinations and Discrete Probability.

**UNIT-II Relations and Functions** - Binary Relations, Equivalence Relations and Partitions, Partial Order Relations and Lattices, Chains and Antichains, Pigeon Hole Principle. **Graphs and Planar Graphs** - Basic Terminology, Multigraphs, Weighted Graphs, Paths and Circuits, Shortest Paths, Eulerian Paths and Circuits, Travelling Salesman Problem, Planner Graphs.

**TREES.**

**UNIT-III Finite State Machines** - Equivalent Machines, Finite State Machines as Language Recognizers, Analysis of Algorithms - Time Complexity, Complexity of Problems, Discrete Numeric Functions and Generating Functions.

**UNIT-IV Recurrence Relations and Recursive Algorithms** - Linear Recurrence Relations with Constant Coefficients, Homogeneous Solutions, Particular Solution, Total Solution, Solution by the Method of Generating Functions, Brief review of Groups and Rings.

**UNIT-V Boolean Algebras** - Lattices and Algebraic Structures, Duality, Distributive and Complemented Lattices, Boolean Lattices and Boolean Algebras, Boolean Functions and Expressions, Propositional Calculus, Design and Implementation of Digital Networks, Switching Circuits.

**REFERENCES :**

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

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**PAPER - III - (OPTIONAL)**

**(III) APPLICATION OF MATHEMATICS IN FINANCE AND INSURANCE**

**(Paper Code-0902)**

**Application of Mathematics in Finance :**

**UNIT-I Financial Management** - An overview. Nature and Scope of Financial Management.

Goals of Financial Management and main decisions of financial management.

Difference between risk, speculation and gambling.

Time value of Money-Interest rate and discount rate. Present value and future value discrete case as well as continuous compounding case. Annuities and its kinds.

**UNIT-II** Meaning of return. Return as Internal Rate of Return (IRR). Numerical Methods like Newton Raphson Method to calculate IRR. Measurement of returns under uncertainty situations. Meaning of risk. Difference between risk and uncertainty. Types of risks. Measurement of risk. Calculation of security and Portfolio Risk and Return-Markowitz Model. Sharpe's Single Index Model Systematic Risk and Unsystematic Risk.

**UNIT-III** Taylor series and Bond Valuation. Calculation of Duration and Convexity of bonds. Financial Derivatives - Futures, Forward, Swaps and Options. Call and Put Option. Call and Put Parity Theorem. Pricing of contingent claims through Arbitrage and Arbitrage Theorem.

**Application of Mathematics in Insurance**

**UNIT-IV** Insurance Fundamentals - Insurance defined. Meaning of loss. Chances of loss, peril, hazard, and proximate cause in insurance. Costs and benefits of insurance to the society and branches of insurance-life insurance and various types of general insurance. Insurable loss exposures feature of a loss that is ideal for insurance. Life Insurance Mathematics - Construction of Mortality Tables. Computation of Premium of Life Insurance for a fixed duration and for the whole life.

**UNIT-V** Determination of claims for General Insurance - Using Poisson Distribution and Negative Binomial Distribution-the Polya Case.

Determination of the amount of Claims in General Insurance - Compound Aggregate claim model and its properties, and claims of reinsurance. Calculation of a compound claim density function. F-recursive and approximate formulae for F.



  
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**REFERENCES :**

1. Aswath Damodaran, Corporate Finance - Theory and Practice, John Wiley & Sons
2. John C. Hull, Options, Futures, and Other Derivatives, Prentice-Hall of India Private Limited.
3. Sheldon M. Ross, An Introduction to Mathematical Finance, Cambridge University Press.
4. Mark S. Dorfman, Introduction to Risk Management and Insurance, Prentice Hall, Englewood Cliffs, New Jersey.
5. C.D. Daykin, T. Pentikainen and M. Pesonen, Practical Risk Theory for Actuaries, Chapman & Hall.



  
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**PAPER - III - (OPTIONAL)**

**Theory component will have maximum marks 30.**

**Practical component will have maximum marks 20.**

**(IV) PROGRAMMING IN C AND NUMERICAL ANALYSIS (Theory & Practical)  
(Paper Code-0903)**

**UNIT-I** Programmer's model of a computer. Algorithms: Flow Charts. Data Types. Arithmetic and input/output instructions. Decisions control structures. Decision statements. Logical and Conditional operators. Loop. Case control structures. Functions. Recursions. Preprocessors. Arrays. Puppeting of strings. Structures. Pointers. File formatting.

**Numerical Analysis**

**UNIT-II** Solution of Equations : Bisection, Secant, Regula Falsi, Newton's Method, Roots of Polynomials : Interpolation : Lagrange and Hermite Interpolation, Divided Differences, Difference Schemes, Interpolation Formulas using Differences. Numerical Differentiation. Numerical Quadrature : Newton-Cote's Formulas. Gauss Quadrature Formulas, Chebychev's Formulas.

**UNIT-III** 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, Lanezos' Method.

**UNIT-IV** 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.

Approximation : Different Types of Approximation, Least Square Polynomial Approximation, Polynomial Approximation using Orthogonal Polynomials, Approximation with Trigonometric Functions, Exponential Functions, Chebychev Polynomials, Rational Functions.

**Unit-V** Monte Carlo Methods Random number generation, congruential generators, statistical tests 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. Henry Mullish & Herbert L. Cooper, Spirit of C : An Introduction to Modern Programming, Jaico Publishers, Bombay.
2. B.W. Kernighan and D.M. Ritchie, The C Programming Language 2<sup>nd</sup> Edition, (ANSI features) Prentice Hall, 1989.
3. Peter A Darnel and Philip E. Margolis, C : A Software Engineering Approach, Narosa Publishing House, 1993.
4. Robert C. Hutchison and Steven B. Just, Programming using C Language, McGraw Hill, 1988.
5. Les Hancock and Morris Krieger, The C Primer, McGraw Hill, 1988.
6. V. Rajaraman, Programming in C, Prentice Hall of India, 1994.
7. Byron S. Gottfried, Theory and Problems of Programming with C, tata McGraw-Hill Publishing Co. Ltd., 1998.
8. C.E. Froberg, Introduction to Numerical Analysis, (Second Edition), Addison-Wesley, 1979.
9. James B. Scarborough, Numerical Mathematical Analysis, Oxford and IBH Publishing Co. Pvt. Ltd. 1966.
10. Melvin J. Maron, Numerical Analysis A Practical Approach, Macmillan publishing Co., Inc. New York, 1982.
11. M.K. Jain, S.R.K. Iyengar, R.K. Jain, Numerical Methods Problems and Solutions, New Age International (P) Ltd., 1996.
12. M.K. Jain, S.R.K. Iyengar, R.K. Jain, Numerical Methods for Scientific and Engineering Computation, New Age International (P) Ltd., 1999.
13. R.Y. Rubistein, Simulation and the Monte Carlo Methods, John Wiley, 1981.
14. D.J. Yakowitz Computational Probability and Simulation, Addison-Wesley, 1977.



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**PAPER - III - (OPTIONAL)**

**(IV) PRACTICAL**

**PROGRAMMING IN C AND NUMERICAL ANALYSIS**

**LIST OF PRACTICAL TO BE CONDUCTED...**

1. Write a program in C to find out the largest number of three integer numbers.
2. Write a program in C to accept monthly salary from the user, find and display income tax with the help of following rules :

Monthly Salary	Income Tax
9000 or more	40% of monthly salary
7500 or more	30% of monthly salary
7499 or less	20% of monthly salary

3. Write a program in C that reads a year and determine whether it is a leap year or not.
4. Write a program in C to calculate and print the first n terms of fibonacci series using looping statement.
5. Write a program in C that reads in a number and single digit. It determines whether the first number contains the digit or not.
6. Write a program in C to computes the roots of a quadratic equation using case statement.
7. Write a program in C to find out the largest number of four numbers using function.
8. Write a program in C to find the sum of all the digits of a given number using recursion.
9. Write a program in C to calculate the factorial of a given number using recursion.
10. Write a program in C to calculate and print the multiplication of given 2D matrices.
11. Write a program in C to check that whether given string palindrome or not.
12. Write a C function seriesum () to calculate the sum of series  
:  $1+X+1/2! X^2+1/3! X^3+..... 1/n! X^n$
13. Write a program in C to determine the grade of all students in the class using Structure. Where structure having following members - name, age, roll, sub 1, sub2, sub3, sub4 and total.
14. Write a program in C to copy one string to another using pointers. (Without using standard library functions).
15. Write a program in C to store the data of five students permanently in a data file using file handling.



**PAPER - III - (OPTIONAL)**

**(V) MATHEMATICAL MODELLING**

**(Paper Code-0904) The Process of Applied mathematics.**

**UNIT-I** Setting up first-order differential equations - Qualitative solution sketching. Difference and differential equation growth models.

**UNIT-II** Single-species population models. Population growth-An age structure model. The spread of Technological innovation.

**UNIT-III** Higher-order linear models- A model for the detection of diabetes. Combat modes.

Traffic models - Car-following models. Equilibrium speed distributions.

**UNIT-IV** Nonlinear population growth models. Prey-Predator models. Epidemic growth models. Models from political science - Proportional representation-cumulative voting, comparison voting.

**UNIT-V** Applications in Ecological and Environmental subject areas- Urban waste water management planning.

**REFERENCES :**

1. Differential equation models, Eds. Martin Braun, C.S. Coleman, D.A. Drew.
2. Political and Related Models, Steven. J. Brams, W.F. Lucas, P.D. Straffin (Eds.)
3. Discrete and System models, W.F. Lucas, F.S. Roberts, R.M. Thrall.
4. Life Science Models, H.M. Roberts & M. Thompson.

All volumes published as modules in applied Mathematics, Springer-Verlag, 1982.

5. Mathematical Modelling by J.N. Kapur, New Age International, New Delhi.



  
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