

Proposed Syllabus and Scheme of Examination

for

B.Sc. with Mathematics and Computer Applications

submitted to

*University Grants Commission
New Delhi*

under the

Choice Based Credit System

May 2015

**Proposed Scheme for Choice Based Credit System in
B.Sc. with Mathematics and Computer Applications**

Semester	Core Course (12)	Ability Enhancement Compulsory Course (AECC) (2)	Skill Enhancement Course (SEC) (2)	Discipline Specific Elective (DSE) (6)
1	Differential Calculus	AECC1		
	Object Oriented Programming in C++			
	C3A			
2	Differential Equations	AECC2		
	Data Structures and File Processing			
	C3B			
3	Real Analysis		SEC1	
	Numerical Computing			
	C3C			
4	Algebra		SEC2	
	Design and Analysis of Algorithms			
	C3D			
5			SEC3	DSE1A
				DSE2A
				DSE3A
6			SEC4	DSE1B
				DSE2B
				DSE3B

Skill Enhancement Course (SEC)

SEC 1 (choose one)

1. Logic and Sets
2. Analytical Geometry
3. Number Theory

SEC 2 (choose one)

1. Vector Calculus
2. Transportation and Game Theory
3. Probability and Statistics

SEC 3 (choose one)

1. Computer Graphics
2. Electronic Commerce
3. Combinatorial Optimization

SEC 4 (choose one)

1. Modeling and Simulation
2. Graph Theory
3. Boolean Algebra

Discipline Specific Electives (DSE)

DSE 1A (choose one)

1. Matrices
2. Integral Calculus
3. Linear Algebra

DSE 2A (choose one)

1. Operating Systems
2. Data Mining
3. Cryptography

DSE 1B (choose one)

1. Difference Equations
2. Complex Analysis
3. Linear Programming

DSE 2B (choose one)

1. Information Security
2. Database Applications
- 3. Computer Networks**

Details of Courses under B.Sc. with Mathematics and Computer Applications

Course	*Credits	
	Theory + Practical	Theory + Tutorials
I. Core Course (12 Papers) 04 Courses from each of the 03 disciplines of choice	$12 \times 4 = 48$	$12 \times 5 = 60$
Core Course Practical / Tutorial* (12 Practical/ Tutorials*) 04 Courses from each of the 03 Disciplines of choice	$12 \times 2 = 24$	$12 \times 1 = 12$
II. Elective Course (6 Papers) Two papers from each discipline of choice including paper of interdisciplinary nature.	$6 \times 4 = 24$	$6 \times 5 = 30$
Elective Course Practical / Tutorials* (6 Practical / Tutorials*) Two Papers from each discipline of choice including paper of interdisciplinary nature	$6 \times 2 = 12$	$6 \times 1 = 6$
• Optional Dissertation or project work in place of one Discipline elective paper (6 credits) in 6th Semester		
III. Ability Enhancement Courses		
1. Ability Enhancement Compulsory (2 Papers of 2 credits each) Environmental Science English/MIL Communication	$2 \times 2 = 4$	$2 \times 2 = 4$

2. Skill Enhancement Course $4 \times 2 = 8$
(Skill Based) (4 Papers of 2 credits each)

$4 \times 2 = 8$

Total credit = 120

Total credit = 120

Institute should evolve a system/ policy about ECA/ General Interest/ Hobby/ Sports/ NCC/ NSS/ related courses on its own.

***wherever there is practical there will be no tutorials and vice -versa**

Core 1.1: Differential Calculus

Limit and Continuity (ϵ and δ definition), Types of discontinuities, Differentiability of functions, Successive differentiation, Leibnitz's theorem, Partial differentiation, Euler's theorem on homogeneous functions.

Tangents and normals, Curvature, Asymptotes, Singular points, Tracing of curves. Parametric representation of curves and tracing of parametric curves, Polar coordinates and tracing of curves in polar coordinates.

Rolle's theorem, Mean Value theorems, Taylor's theorem with Lagrange's and Cauchy's forms of remainder, Taylor's series, Maclaurin's series of $\sin x$, $\cos x$, e^x , $\log(1+x)$, $(1+x)^m$, Maxima and Minima, Indeterminate forms.

Books Recommended

1. H. Anton, I. Birens and S. Davis, *Calculus*, John Wiley and Sons, Inc., 2002.
2. G.B. Thomas and R.L. Finney, *Calculus*, Pearson Education, 2007.

Core 1.2: Object Oriented Programming in C++

Programming Concepts: Algorithm and its characteristics, pseudo code / flow chart, program, identifiers, variables, constants, primitive data types, expressions, structured data types, arrays, compilers and interpreters.

Statements: Assignment statement, if then else statements, switch statement, looping statements- while, do while, for, break, continue, input/output statements, functions/procedures. Object Oriented Concepts: Abstraction, encapsulation, objects, classes, methods, constructors, inheritance, polymorphism, static and dynamic binding, overloading. Program Development: Object oriented analysis, design, unit testing & debugging, system testing & integration, maintenance.

Introduction to structured programming: data types- simple data types, floating data types, character data types, string data types, arithmetic operators and operator precedence, variables and constant declarations, expressions, input using the extraction operator >> and cin, output using the insertion operator << and cout, preprocessor directives, increment (++) and decrement operations (--), creating a C++ program, input/output, relational operators, logical operators and logical expressions, if and if ... else statement, switch and break statements.

“for”, “while” and “do – while” loops, break and continue statement, nested control statement, value returning functions, void functions, value versus reference parameters, local and global variables, static and automatic variables, enumeration type, one dimensional array, two dimensional array, character array, pointer data and pointer variables.

Books Recommended

1. Richard Johnson, *An Introduction to Object-Oriented Application Development*, Thomson Learning, 2006
2. B. Stroustrup, *The C++ Programming Language*, Addison Wesley, 2004.

Core 2.1: Differential Equations

First order exact differential equations. Integrating factors, rules to find an integrating factor. First order higher degree equations solvable for x , y , p . Methods for solving higher-order differential equations. Basic theory of linear differential equations, Wronskian, and its properties. Solving a differential equation by reducing its order.

Linear homogenous equations with constant coefficients, Linear non-homogenous equations, The method of variation of parameters, The Cauchy-Euler equation, Simultaneous differential equations, Total differential equations.

Order and degree of partial differential equations, Concept of linear and non-linear partial differential equations, Formation of first order partial differential equations, Linear partial differential equation of first order, Lagrange's method, Charpit's method.

Classification of second order partial differential equations into elliptic, parabolic and hyperbolic through illustrations only.

Books Recommended

1. Shepley L. Ross, *Differential Equations*, 3rd Ed., John Wiley and Sons, 1984.
2. I. Sneddon, *Elements of Partial Differential Equations*, McGraw-Hill, International Edition, 1967.

Core 2.2: Data Structures and File Processing

Basic Data Structures: Abstract data structures- stacks, queues, linked lists and binary trees. Sets: Dictionary implementation, use of priority queues, hashing, binary trees, balanced trees, sets with merge-find operations.

Searching: Internal and external searching, use of hashing and balancing techniques.

Memory Management: Garbage collection algorithms for equal sized blocks, storage allocation for objects with mixed size, buddy systems.

Physical Devices: Characteristics of storage devices such as disks and tapes, I/O buffering. Basic File System Operations: Create, open, close, extend, delete, read-block, write-block, protection mechanisms.

File Organizations: Sequential, indexed sequential, direct, inverted, multi-list, directory systems, Indexing using B-tree, B+ tree and their variants, hashing – hash function, collision handling methods, extendible hashing.

Books Recommended

1. M.T. Goodrich, R. Tamassia and D. Mount, *Data Structures and Algorithms in C++*, John Wiley and Sons, Inc., 2004.
2. T.H. Cormen, C.E. Leiserson, R.L. Rivest and C. Stein, *Introduction to Algorithms*, 2nd Ed., Prentice-Hall of India, 2006.
3. Robert L. Kruse and A.J. Ryba, *Data Structures and Program Design in C++*, Prentice Hall, Inc., NJ, 1998.
4. B. Stroustrup, *The C++ Programming Language*, Addison Wesley, 2004
5. D.E. Knuth, *Fundamental Algorithms* (Vol. I), Addison Wesley, 1997

Core 3.1: Real Analysis

Finite and infinite sets, examples of countable and uncountable sets. Real line, bounded sets, suprema and infima, completeness property of \mathbb{R} , Archimedean property of \mathbb{R} , intervals. Concept of cluster points and statement of Bolzano-Weierstrass theorem.

Real Sequence, Bounded sequence, Cauchy convergence criterion for sequences. Cauchy's theorem on limits, order preservation and squeeze theorem, monotone sequences and their convergence (monotone convergence theorem without proof).

Infinite series. Cauchy convergence criterion for series, positive term series, geometric series, comparison test, convergence of p-series, Root test, Ratio test, alternating series, Leibnitz's test (Tests of Convergence without proof). Definition and examples of absolute and conditional convergence.

Sequences and series of functions, Pointwise and uniform convergence. M_n -test, M-test, Statements of the results about uniform convergence and integrability and differentiability of functions, Power series and radius of convergence.

Books Recommended

1. T.M. Apostol, *Calculus* (Vol. I), John Wiley and Sons (Asia) P. Ltd., 2002.
2. R.G. Bartle and D. R Sherbert, *Introduction to Real Analysis*, John Wiley and Sons (Asia) P. Ltd., 2000.
3. E. Fischer, *Intermediate Real Analysis*, Springer Verlag, 1983.
4. K.A. Ross, *Elementary Analysis- The Theory of Calculus Series-* Undergraduate Texts in Mathematics, Springer Verlag, 2003.

Core 3.2: Numerical Computing

Solution to Transcendental and Polynomial Equations: Iterative methods, bisection method, secant method, Newton-Raphson method, fixed point iteration, methods for finding complex roots. Matrices and Linear System of Equations: LU decomposition method for solving systems of equations, Symmetric positive definite matrices and least square approximation, iterative algorithms for linear equations.

Interpolation: Polynomial interpolation, Newton-Gregory, Stirling's, Bessel's and Lagrange's interpolation formula, Newton's divided differences interpolation formulae. Curve fitting: B-spline and Approximation: Fitting linear and non-linear curves, weighted least square approximation, method of least square for continuous functions.

Numerical Differentiation and Integration: Numerical differentiation and errors in numerical differentiation, Newton-Cotes formulae, trapezoidal rule, Simpson's rule, Gaussian integration. Numerical Solutions of Ordinary Differential Equations: Picard's and Taylor's series, Euler's and Runge-Kutta (RK) methods. Finite Element Method: Boundary value problems, Rayleigh and Galerkin methods of approximation, applications.

Books Recommended

1. K.E. Atkinson, W. Han, *Elementary Numerical Analysis*, 3rd Ed., Wiley, 2003.
2. C. Xavier, S.S. Iyengar, *Introduction to Parallel Algorithms*, Wiley-Interscience, 1998.
3. A. Kharab, R.B. Guenther, *An Introduction to Numerical Methods: A MATLAB Approach*, 1st Ed., Chapman and Hall/CRC, 2001.
4. B. Bradie, *A Friendly Introduction to Numerical Analysis*, Pearson Education, 2007.
5. S.R. Otto and J.P. Denier, *An Introduction to Programming and Numerical Methods in MATLAB*, Springer, 2005.
6. M.K. Jain, S.R.K. Iyengar and R.K. Jain, *Numerical Methods for Scientific and Engineering Computation*, 7th Ed., New Age International Publishers, 2007.

Core 4.1: Algebra

Definition and examples of groups, examples of abelian and non-abelian groups, the group Z_n of integers under addition modulo n and the group $U(n)$ of units under multiplication modulo n . Cyclic groups from number systems, complex roots of unity, circle group, the general linear group $GL_n(n, \mathbb{R})$, groups of symmetries of (i) an isosceles triangle, (ii) an equilateral triangle, (iii) a rectangle, and (iv) a square, the permutation group $\text{Sym}(n)$, Group of quaternions.

Subgroups, cyclic subgroups, the concept of a subgroup generated by a subset and the commutator subgroup of group, examples of subgroups including the center of a group. Cosets, Index of subgroup, Lagrange's theorem, order of an element, Normal subgroups: their definition, examples, and characterizations, Quotient groups.

Definition and examples of rings, examples of commutative and non-commutative rings: rings from number systems, Z_n the ring of integers modulo n , ring of real quaternions, rings of matrices, polynomial rings, and rings of continuous functions. Subrings and ideals, Integral domains and fields, examples of fields: Z_p , \mathbb{Q} , \mathbb{R} , and \mathbb{C} . Field of rational functions.

Books Recommended

1. John B. Fraleigh, *A First Course in Abstract Algebra*, 7th Ed., Pearson, 2002.
2. M. Artin, *Abstract Algebra*, 2nd Ed., Pearson, 2011.
3. Joseph A Gallian, *Contemporary Abstract Algebra*, 4th Ed., Narosa Publication, 1999.
4. George E Andrews, *Number Theory*, Hindustan Publishing Corporation, 1984.

Core 4.2: Design and Analysis of Algorithms

Introduction: RAM model, $O(\log n)$ bit model. Review of data structures: Balanced trees, Mergeable sets. Algorithm Design Techniques: Iterative techniques, Divide and conquer, dynamic programming, greedy algorithms.

Searching and Sorting Techniques: Review of elementary sorting techniques-selection sort, bubble sort, insertion sort, more sorting techniques-quick sort, heap sort, merge sort, shell sort, external sorting.

Lower bounding techniques: Decision Trees, Adversaries. String Processing: KMP, Boyre-Moore, Robin Karp algorithms.

Introduction to randomized algorithms: Random numbers, randomized Qsort, randomly Built BST Number Theoretic Algorithms: GCD, Addition and Multiplication of two large numbers, polynomial arithmetic, Fast-Fourier Transforms.

Graphs: Analysis of Graph algorithms Depth-First Search and its applications, minimum Spanning Trees and Shortest Paths. Introduction to Complexity Theory: Class P, NP, NP-Hard, NP Completeness. Introduction to Approximation Algorithms

Books Recommended

1. T.H. Cormen, C.E. Leiserson, R.L. Rivest and C. Stein, *Introduction to Algorithms*, Prentice-Hall of India, 2006.
2. J. Kleinberg and E. Tardos, *Algorithms Design*, Pearson Education, 2006.
3. S. Baase, *Computer Algorithms: Introduction to Design and Analysis*, Addison Wesley, 1999.
4. A.V. Levitin, *Introduction to the Design and Analysis of Algorithms*, Pearson Education, 2006.

SEC 1.1: Logic and Sets

Introduction, propositions, truth table, negation, conjunction and disjunction. Implications, biconditional propositions, converse, contra positive and inverse propositions and precedence of logical operators. Propositional equivalence: Logical equivalences. Predicates and quantifiers: Introduction, Quantifiers, Binding variables and Negations.

Sets, subsets, Set operations, the laws of set theory and Venn diagrams. Examples of finite and infinite sets. Finite sets and counting principle. Empty set, properties of empty set. Standard set operations. Classes of sets. Power set of a set.

Difference and Symmetric difference of two sets. Set identities, Generalized union and intersections. Relation: Product set, Composition of relations, Types of relations, Partitions, Equivalence Relations with example of congruence modulo relation.

Book Recommended

1. R.P. Grimaldi, *Discrete Mathematics and Combinatorial Mathematics*, Pearson Education, 1998.
2. P.R. Halmos, *Naive Set Theory*, Springer, 1974.
3. E. Kamke, *Theory of Sets*, Dover Publishers, 1950.

SEC 1.2: Analytical Geometry

Techniques for sketching parabola, ellipse and hyperbola. Reflection properties of parabola, ellipse and hyperbola. Classification of quadratic equations representing lines, parabola, ellipse and hyperbola. Spheres, Cylindrical surfaces. Illustrations of graphing standard quadric surfaces like cone, ellipsoid.

Books Recommended

1. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.
2. H. Anton, I. Bivens and S. Davis, *Calculus*, John Wiley and Sons (Asia) Pvt. Ltd. 2002.
3. S.L. Loney, *The Elements of Coordinate Geometry*, McMillan and Company, London.
4. R.J.T. Bill, *Elementary Treatise on Coordinate Geometry of Three Dimensions*, McMillan India Ltd., 1994.

SEC 1.3: Number Theory

Division algorithm, Lame's theorem, linear Diophantine equation, fundamental theorem of arithmetic, prime counting function, statement of prime number theorem, Goldbach conjecture, binary and decimal representation of integers, linear congruences, complete set of residues.

Number theoretic functions, sum and number of divisors, totally multiplicative functions, definition and properties of the Dirichlet product, the Mobius inversion formula, the greatest integer function, Euler's phi-function.

Books Recommended:

1. David M. Burton, *Elementary Number Theory*, 6th Ed., Tata McGraw-Hill Edition, Indian reprint, 2007.
2. Richard E. Klima, Neil Sigmon, Ernest Stitzinger, *Applications of Abstract Algebra with Maple*, CRC Press, Boca Raton, 2000.
3. Neville Robinns, *Beginning Number Theory*, 2nd Ed., Narosa Publishing House Pvt. Limited, Delhi, 2007.

SEC 2.1: Vector Calculus

Differentiation and partial differentiation of a vector function. Derivative of sum, dot product and cross product of two vectors. Gradient, divergence and curl.

Books Recommended

1. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.
2. H. Anton, I. Bivens and S. Davis, *Calculus*, John Wiley and Sons (Asia) P. Ltd. 2002.
3. P.C. Matthew's, *Vector Calculus*, Springer Verlag London Limited, 1998.

SEC 2.2: Transportation and Game Theory

Transportation problem and its mathematical formulation, northwest-corner method, least cost method and Vogel approximation method for determination of starting basic solution, algorithm for solving transportation problem, assignment problem and its mathematical formulation, Hungarian method for solving assignment problem.

Game theory: formulation of two person zero sum games, solving two person zero sum games, games with mixed strategies, graphical solution procedure.

Books Recommended

1. Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, *Linear Programming and Network Flows*, 2nd Ed., John Wiley and Sons, India, 2004.
2. F.S. Hillier and G.J. Lieberman, *Introduction to Operations Research*, 9th Ed., Tata McGraw Hill, Singapore, 2009.
3. Hamdy A. Taha, *Operations Research, An Introduction*, 8th Ed., Prentice-Hall India, 2006.

SEC 2.3: Probability and Statistics

Sample space, probability axioms, real random variables (discrete and continuous), cumulative distribution function, probability mass/density functions, mathematical expectation, moments, moment generating function, characteristic function, discrete distributions: uniform, binomial, Poisson, continuous distributions: uniform, normal, exponential.

Joint cumulative distribution function and its properties, joint probability density functions, marginal and conditional distributions, expectation of function of two random variables, conditional expectations, independent random variables.

Books Recommended

1. Robert V. Hogg, Joseph W. McKean and Allen T. Craig, *Introduction to Mathematical Statistics*, Pearson Education, Asia, 2007.
2. Irwin Miller and Marylees Miller and John E. Freund, *Mathematical Statistics with Applications*, 7th Ed., Pearson Education, Asia, 2006.
3. Sheldon Ross, *Introduction to Probability Models*, 9th Ed., Academic Press, Indian Reprint, 2007.

SEC 3.1: Computer Graphics

Development of computer Graphics: Raster Scan and Random Scan graphics storages, displays processors and character generators, colour display techniques, interactive input/output devices.

Points, lines and curves: Scan conversion, line-drawing algorithms, circle and ellipse generation, conic-section generation, polygon filling anti aliasing.

Two-dimensional viewing: Coordinate systems, linear transformations, line and polygon clipping algorithms.

Books Recommended

1. D. Hearn and M.P. Baker, *Computer Graphics*, 2nd Ed., Prentice–Hall of India, 2004.
2. J.D. Foley, A van Dam, S.K. Feiner and J.F. Hughes, *Computer Graphics: Principals and Practices*, 2nd Ed., Addison-Wesley, MA, 1990.
3. D.F. Rogers, *Procedural Elements in Computer Graphics*, 2nd Ed., McGraw Hill Book Company, 2001.
4. D.F. Rogers and A.J. Admas, *Mathematical Elements in Computer Graphics*, 2nd Ed., McGraw Hill Book Company, 1990.

SEC 3.2: Electronic Commerce

Building Blocks of Electronic Commerce: Introduction, internet and networking technologies, Internet and network protocols, web server scalability, software technologies for building E-commerce applications, distributed objects, object request brokers, component technology, web services, web application architectures.

Design of auction, optimization algorithms, for market places, multi-agent systems.

Global E-commerce and Law: Cyber law in India. Comparative evaluation of Cyber laws of certain countries.

Books Recommended

1. E.M. Awad, *Electronic Commerce from Vision to Fulfillment*, 3rd Ed., Prentice-Hall of India, 2006
2. P.T. Joseph, *E-Commerce: An Indian Perspective*, Prentice-Hall of India, 2007.
3. Scott Bonneau, Tammy Kohl, Jeni Tennison, Jon Duckett and Kevin Williams, *XML Design Handbook*, Wrox Press Ltd., 2003.
4. Michael Cheslar, Ricky Kaura, and Peter Linton, *Electronic Business and Commerce*, Springer, 2003.
5. W.J. Pardi, *XML in Action: Learn to Quickly Create Dynamic, Data-driven Sites with the Web's Hottest New Technology*, Prentice Hall of India, 1999.
6. P. Weill and M.R. Vitale, *Place to Space: Migrating to eBusiness Models*, Harvard Business School Press, 2001.
7. D. Whiteley, *E-commerce: Strategy, Technologies and Applications*, Tata McGraw-Hill Edition, 2001.
8. M. Fitzgerald, *Building B2B Applications with XML: A Resource Guide*, John Wiley and Sons, Inc., 2001.

SEC 3.3: Combinatorial Optimization

Introduction: Optimization problems, neighbourhoods, local and global optima, convex sets and functions, simplex method, degeneracy; duality and dual simplex algorithm, computational considerations for the simplex and dual simplex algorithms-Dantzig-Wolfe algorithms.

Integer Linear Programming: Cutting plane algorithms, branch and bound technique and approximation algorithms for travelling salesman problem.

Books Recommended

1. C.H. Papadimitriou and K. Steiglitz, *Combinatorial Optimization: Algorithms and Complexity*, Prentice-Hall of India, 2006
2. K. Lange, *Optimization*, Springer, 2004.
3. Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, *Linear Programming and Network Flows*, John Wiley and Sons, 2004.
4. H.A. Taha, *Operations Research: An Introduction*, 8th Ed., Prentice Hall, 2006.

SEC 4.1: Modeling and Simulation

Systems and environment: Concept of model and model building, model classification and representation, Use of simulation as a tool, steps in simulation study.

Continuous-time and Discrete-time systems: Laplace transform, transfer functions, state space models, order of systems, z-transform, feedback systems, stability, observability, controllability. Statistical Models in Simulation: Common discrete and continuous distributions, Poisson process, empirical distributions.

Random Numbers: Properties of random numbers, generation of pseudo random numbers, techniques of random number generation, tests for randomness, random variate generation using inverse transformation, direct transformation, convolution method, acceptance-rejection.

Books Recommended

1. Narsingh Deo, *System Simulation with Digital Computer*, Prentice Hall of India, 1999.
2. Averill Law, *Simulation Modeling and Analysis*, 3rd Ed., Tata McGraw-Hill, 2007.
3. G. Gordan, *System Simulation*, 2nd Ed., Pearson Education, 2007.
4. A.F. Seila, V. Ceric and P. Tadikamalla, *Applied Simulation Modeling* (International Student Edition), Thomson Learning, 2004.
5. Jerry Banks, *Handbook of Simulation: Principles, Methodology, Advances, Applications and Practice*, Wiley Inter Science, 1998.
6. J. Banks, J.S. Carson, B.L. Nelson, *Discrete Event System Simulation*, 4th Ed., Prentice Hall of India, 2004.
7. N.A. Kheir, *Systems Modeling and Computer Simulation*, Marcel Dekker, 1988.
8. B.P. Zeigler, T.G. Kim, and H. Praehofer, *Theory of Modeling and Simulation*, 2nd Ed., Academic Press, 2000.

SEC 4.2: Graph Theory

Definition, examples and basic properties of graphs, pseudo graphs, complete graphs, bi-partite graphs, isomorphism of graphs, paths and circuits, Eulerian circuits, Hamiltonian cycles, the adjacency matrix, weighted graph, travelling salesman's problem, shortest path, Dijkstra's algorithm, Floyd-Warshall algorithm.

Books Recommended

1. Edgar G. Goodaire and Michael M. Parmenter, *Discrete Mathematics with Graph Theory*, 2nd Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint 2003.
2. Rudolf Lidl and Günter Pilz, *Applied Abstract Algebra*, 2nd Ed., Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.

SEC 4.3: Boolean Algebra

Definition, examples and basic properties of ordered sets, maps between ordered sets, duality principle, maximal and minimal elements, lattices as ordered sets, complete lattices, lattices as algebraic structures, sublattices, products and homomorphisms.

Definition, examples and properties of modular and distributive lattices, Boolean algebras, Boolean polynomials, minimal forms of Boolean polynomials, Quinn-McCluskey method, Karnaugh diagrams, switching circuits and applications of switching circuits.

Books Recommended

1. B A. Davey and H.A. Priestley, *Introduction to Lattices and Order*, Cambridge University Press, Cambridge, 1990.
2. Rudolf Lidl and Günter Pilz, *Applied Abstract Algebra*, 2nd Ed., Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.

DSE 1A.1: Matrices

\mathbb{R} , \mathbb{R}^2 , \mathbb{R}^3 as vector spaces over \mathbb{R} . Standard basis for each of them. Concept of Linear Independence and examples of different bases. Subspaces of \mathbb{R}^2 , \mathbb{R}^3 . Translation, Dilation, Rotation, Reflection in a point, line and plane.

Matrix form of basic geometric transformations. Interpretation of eigen values and eigenvectors for such transformations and eigen spaces as invariant subspaces. Matrices in diagonal form. Reduction to diagonal form upto matrices of order 3.

Computation of matrix inverses using elementary row operations. Rank of matrix. Solutions of a system of linear equations using matrices. Illustrative examples of above concepts from Geometry, Physics, Chemistry, Combinatorics and Statistics.

Books Recommended

1. A.I. Kostrikin, *Introduction to Algebra*, Springer Verlag, 1984.
2. S. H. Friedberg, A. L. Insel and L. E. Spence, *Linear Algebra*, Prentice Hall of India Pvt. Ltd., New Delhi, 2004.
3. Richard Bronson, *Theory and Problems of Matrix Operations*, Tata McGraw Hill, 1989.

DSE 1A.2: Integral Calculus

Integration by Partial fractions, integration of rational and irrational functions. Properties of definite integrals. Reduction formulae for integrals of rational, trigonometric, exponential and logarithmic functions and of their combinations.

Areas and lengths of curves in the plane, volumes and surfaces of solids of revolution. Double and Triple integrals.

Books Recommended

1. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.
2. H. Anton, I. Bivens and S. Davis, *Calculus*, John Wiley and Sons (Asia) P. Ltd. 2002.

DSE 1A.3: Linear Algebra

Vector spaces, subspaces, algebra of subspaces, quotient spaces, linear combination of vectors, linear span, linear independence, basis and dimension, dimension of subspaces.

Linear transformations, null space, range, rank and nullity of a linear transformation, matrix representation of a linear transformation, algebra of linear transformations. Dual Space, Dual Basis, Double Dual, Eigen values and Eigen vectors, Characteristic Polynomial.

Isomorphisms, Isomorphism theorems, invertibility and isomorphisms, change of coordinate matrix.

Books Recommended

1. Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, *Linear Algebra*, 4th Ed., Prentice-Hall of India Pvt. Ltd., New Delhi, 2004.
2. David C. Lay, *Linear Algebra and its Applications*, 3rd Ed., Pearson Education Asia, Indian Reprint, 2007.
3. S. Lang, *Introduction to Linear Algebra*, 2nd Ed., Springer, 2005.
4. Gilbert Strang, *Linear Algebra and its Applications*, Thomson, 2007.

DSE 2A.1: Operating Systems

Introduction: Operating System as a resource manager, operating system classification, system calls, traps, architectures for operating systems. Device Management: Goals of I/O software, Design of device drivers. Processor Management: Process overview, process states and state transition, multiprogramming, multi-tasking, levels of schedulers and scheduling algorithms. Process Synchronization - Critical section and mutual exclusion problem, classical synchronization problems, deadlock prevention. Multithreading Memory Management: Classical memory management techniques, paging, segmentation, virtual memory. File Management: Overview of file management system, disk space management, directory structures. Protection domains, access control lists, protection models.

Books Recommended

1. A.S. Tanenbaum, *Modern Operating Systems*, 3rd Ed., Prentice-Hall of India, 2008.
2. William Stallings, *Operating Systems: Internals and Design Principles*, 5th Ed., Prentice-Hall of India, 2006.
3. Gary Nutt, *Operating Systems: A Modern Approach*, 3rd Ed., Addison Wesley, 2004.
4. D.M. Dhamdhere, *Operating Systems: A Concept Based Approach*, 2nd Ed., Tata McGraw-Hill, 2007.

DSE 2A.2: Data Mining

Overview: The process of knowledge discovery in databases, predictive and descriptive data mining techniques, supervised and unsupervised learning techniques. Techniques of Data Mining: Link analysis, predictive modeling, database segmentation, score functions for data mining algorithms, Bayesian techniques in data mining. Issues in Data Mining: Scalability and data management issues in data mining algorithms, parallel and distributed data mining, privacy, social, ethical issues in KDD and data mining, pitfalls of KDD and data mining.

Books Recommended

1. Margaret H. Dunham, *Data Mining: Introductory and Advanced Topics*, Pearson, 2002.
2. Jiawei Han and Micheline Kamber, *Data Mining: Concepts and Techniques*, 2nd Ed., Morgan Kaufmann, 2006.
3. Arun Pujari, *Data Mining Techniques*, University Press, 2001.
4. D. Hand, H. Mannila and P. Smyth, *Principles of Data Mining*, Prentice-Hall of India, 2006.
5. G.K. Gupta, *Introduction to Data Mining with Case Studies*, Prentice-Hall of India, 2006.

DSE 2A.3: Cryptography

Elementary number theory: Prime numbers, Fermat's and Euler's theorems, Testing for primality, Chinese remainder theorem, discrete logarithms. Finite fields: Review of groups, rings and fields; Modular Arithmetic, Euclidean Algorithms, Finite fields of the form $GF(p)$, Polynomial Arithmetic, Finite fields of the form $GF(2)$. Data Encryption Techniques: Algorithms for block and stream ciphers, private key encryption – DES, AES, RC4; Algorithms for public key encryption – RSA, DH Key exchange, KERBEROS, elliptic curve cryptosystems. Message authentication and hash functions, Digital Signatures and authentication protocols, Public key infrastructure, Cryptanalysis of block and stream ciphers.

Book Recommended

1. W. Stallings, *Cryptography and Network Security Principles and Practices*, 4th Ed., Prentice-Hall of India, 2006.
2. C. Pfleeger and S.L. Pfleeger, *Security in Computing*, 3rd Ed., Prentice-Hall of India, 2007.
3. M.Y. Rhee, *Network Security*, John Wiley and Sons, NY, 2002.

DSE 1B.1: Difference Equations

Difference Calculus: Introduction, The Difference Operator, Summation, Generating Functions and Approximate Summation.

Linear Difference Equations: First Order Equations, General Results for Linear Equations, Solving Linear Equations, Applications, Equations with Variable Coefficients, Nonlinear Equations that can Be Linearized, The z-Transform.

Stability Theory: Initial Value Problems for Linear Systems, Stability of Linear Systems, Phase Plane Analysis for Linear Systems, Fundamental Matrices and Floquet Theory, Stability of Nonlinear Systems, Chaotic Behavior.

Asymptotic Methods: Introduction, Asymptotic Analysis of Sums, Linear Equations, Nonlinear Equations.

Books Recommended

1. Walter Kelley and Allan Peterson, *Difference Equations, An Introduction with Applications*, Academic Press, 1991.
2. Calvin Ahlbrant and Allan Peterson, *Discrete Hamiltonian Systems, Difference Equations, Continued Fractions and Riccati Equations*, Kluwer, 1996.
3. Saber Elaydi, *An Introduction to Difference Equations*, Springer, 1999.

DSE 1B.2: Complex Analysis

Limits, Limits involving the point at infinity, continuity. Properties of complex numbers, regions in the complex plane, functions of complex variable, mappings. Derivatives, differentiation formulas, Cauchy-Riemann equations, sufficient conditions for differentiability.

Analytic functions, examples of analytic functions, exponential function, Logarithmic function, trigonometric function, derivatives of functions, definite integrals of functions. Contours, Contour integrals and its examples, upper bounds for moduli of contour integrals. Cauchy-Goursat theorem, Cauchy integral formula.

Liouville's theorem and the fundamental theorem of algebra. Convergence of sequences and series, Taylor series and its examples.

Laurent series and its examples, absolute and uniform convergence of power series.

Books Recommended

1. James Ward Brown and Ruel V. Churchill, *Complex Variables and Applications*, 8th Ed., McGraw – Hill International Edition, 2009.
2. Joseph Bak and Donald J. Newman, *Complex analysis*, 2nd Ed., Undergraduate Texts in Mathematics, Springer-Verlag New York, Inc., 1997.

DSE 1B.3: Linear Programming

Linear Programming Problems, Graphical Approach for Solving some Linear Programs. Convex Sets, Supporting and Separating Hyperplanes.

Theory of simplex method, optimality and unboundedness, the simplex algorithm, simplex method in tableau format, introduction to artificial variables, two-phase method, Big-M method and their comparison.

Duality, formulation of the dual problem, primal- dual relationships, economic interpretation of the dual, sensitivity analysis.

Books Recommended

1. Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, *Linear programming and Network Flows*, 2nd Ed., John Wiley and Sons, India, 2004.
2. F. S. Hillier and G. J. Lieberman, *Introduction to Operations Research*, 8th Ed., Tata McGraw Hill, Singapore, 2004.
3. Hamdy A. Taha, *Operations Research, An Introduction*, 8th Ed., Prentice- Hall India, 2006.

DSE 2B.1: Information Security

Overview of Security: Protection versus security; aspects of security–data integrity, data availability, privacy; security problems, user authentication, Orange Book. Security Threats: Program threats, worms, viruses, Trojan horse, trap door, stack and buffer overflow; system threats- intruders; communication threats- tapping and piracy. Cryptography: Substitution, transposition ciphers, symmetric-key algorithms-Data Encryption Standard, advanced encryption standards, public key encryption - RSA; Diffie-Hellman key exchange, ECC cryptography, Message Authentication- MAC, hash functions. Digital signatures: Symmetric key signatures, public key signatures, message digests, public key infrastructures. Security Mechanisms: Intrusion detection, auditing and logging, tripwire, system-call monitoring;

Books Recommended

1. W. Stallings, *Cryptography and Network Security Principles and Practices*, 4th Ed., Prentice-Hall of India, 2006.
2. C. Pfleeger and SL. Pfleeger, *Security in Computing*, 3rd Ed., Prentice-Hall of India, 2007.
3. D. Gollmann, *Computer Security*, John Wiley and Sons, NY, 2002.
4. J. Piwprzyk, T. Hardjono and J. Seberry, *Fundamentals of Computer Security*, Springer-Verlag Berlin, 2003.
5. J.M. Kizza, *Computer Network Security*, Springer, 2007.
6. M. Merkow and J. Breithaupt, *Information Security: Principles and Practices*, Pearson Education, 2006.

DSE 2B.2: Database Applications

Application Design and Development: User interfaces and tools, web interfaces to Databases
Web Fundamentals: HTML, static vs. dynamic web pages, client (Java script/VB) and server side scripting (JSP/ASP/PHP/VB), web servers and sessions, two level & three level architecture, Real Life Application Development using Popular DBMS: SQL, procedures & functions, exception handling, triggers, large objects, user defined data types, collection types, bulk loading of data.

Query Optimization: Query Processing, query tree, query plans, measures of query cost, estimates of basic operations, equivalent relational algebra expressions, evaluation of expressions.

Authorizations in SQL: System and user privileges, granting and revoking privileges, roles, authorization on views, functions and procedures, limitations of SQL authorizations, audit trails
Application Security: Encryption techniques, digital signatures and digital certificates.

Books Recommended

1. A. Silberschatz, H. Korth and S. Sudarshan, *Database System Concepts*, 5th Ed., Tata McGraw Hill, 2006.
2. J. Morrison, M. Morrison and R. Conrad, *Guide to Oracle 10g*, Thomson Learning, 2005.
3. Loney and Koch, *Oracle 10g: The Complete Reference*, Tata McGraw Hill, 2006.
4. David Flanagan, Java Script, *The Definitive Guide*, O'Reilly Media, 2006.
5. Marty Hall, Larry Brown, and Yaakov Chaikin, *Core Servlets and Java Server Pages: Core Technologies* (Vol. II), 2nd Ed., Sun Microsystems Press, 2006.
6. S.K. Singh, *Database Systems Concepts, Design and Applications*, Pearson Education 2006.

DSE 2B.3: Computer Networks

Basic Concepts: Components of data communication, distributed processing, Line configuration, topology, transmission mode, and categories of networks. OSI and TCP/IP Models: Layers and their functions, comparison of models. Digital Transmission: Interfaces and Modems: DTE-DCE Interface, modems, cable modems. Transmission Media: Guided and unguided, Attenuation, distortion, noise, throughput, propagation speed and time, wavelength, Shannon Capacity.

Telephony: Multiplexing, error detection and correction, Many to one, one to many, WDM, TDM, FDM, circuit switching, packet switching and message switching. Data Link control protocols: Line discipline, flow control, error control, synchronous and asynchronous protocols overview. ISDN: Services, historical outline, subscriber's access, ISDN, Layers, and broadband ISDN.

Devices: Repeaters, bridges, gateways, routers, The Network Layer, Design Issues, Network Layer Addressing and Routing concepts (Forwarding Function, Filtering Function); Routing Methods (Static and dynamic routing, Distributed routing, Hierarchical Routing); Distance Vector Protocol, Link State protocol.

Transport and upper layers in OSI Model: Transport layer functions, connection management, Functions of session layers, Presentation layer, and Application layer.

Books Recommended

1. A.S. Tanenbaum, *Computer Networks*, 4th Ed., Pearson Education Asia, 2003.
2. Behrouz A. Forouzan, *Data Communication and Networking*, 2nd Ed., Tata McGraw Hill.
3. D. E. Comer, *Internetworking with TCP/IP*, Pearson Education Asia, 2001.
4. William Stallings, *Data and Computer Communications*, 7th Ed., Pearson education Asia, 2002.