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

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

<table>
<thead>
<tr>
<th>Course</th>
<th>*Credits</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Theory + Practical</td>
</tr>
<tr>
<td>I.  Core Course</td>
<td>12×4 = 48</td>
</tr>
<tr>
<td>(12 Papers)</td>
<td></td>
</tr>
<tr>
<td>04 Courses from each of the</td>
<td></td>
</tr>
<tr>
<td>03 disciplines of choice</td>
<td></td>
</tr>
<tr>
<td>Core Course Practical / Tutorial*</td>
<td>12×2 = 24</td>
</tr>
<tr>
<td>(12 Practical/ Tutorials*)</td>
<td></td>
</tr>
<tr>
<td>04 Courses from each of the</td>
<td></td>
</tr>
<tr>
<td>03 Disciplines of choice</td>
<td></td>
</tr>
<tr>
<td>II. Elective Course</td>
<td>6×4 = 24</td>
</tr>
<tr>
<td>(6 Papers)</td>
<td></td>
</tr>
<tr>
<td>Two papers from each discipline of choice</td>
<td></td>
</tr>
<tr>
<td>including paper of interdisciplinary nature</td>
<td></td>
</tr>
<tr>
<td>Elective Course Practical / Tutorials*</td>
<td>6×2 = 12</td>
</tr>
<tr>
<td>(6 Practical / Tutorials*)</td>
<td></td>
</tr>
<tr>
<td>Two Papers from each discipline of choice</td>
<td></td>
</tr>
<tr>
<td>including paper of interdisciplinary nature</td>
<td></td>
</tr>
</tbody>
</table>

• 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 2×2 = 4 2×2 = 4
(2 Papers of 2 credits each)
Environmental Science
English/MIL Communication
2. Skill Enhancement Course \[4 \times 2 = 8\]  \[4 \times 2 = 8\] 
(Skill Based) (4 Papers of 2 credits each) 
_________________________________  ____________________________________ 
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.


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)^n, Maxima and Minima, Indeterminate forms.

Books Recommended


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

Core 2.1: Differential Equations


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

Books Recommended


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


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 R, Archimedean property of 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. Mₙ-test, M-test, Statements of the results about uniform convergence and integrability and differentiability of functions, Power series and radius of convergence.

Books Recommended


Core 3.2: Numerical Computing


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


Books Recommended


Core 4.1: Algebra

Definition and examples of groups, examples of abelian and non-abelian groups, the group $\mathbb{Z}_n$ of integers under addition modulo n and the group $\text{U}(n)$ of units under multiplication modulo n. Cyclic groups from number systems, complex roots of unity, circle group, the general linear group $\text{GL}_n(n,\mathbb{R})$, 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 a 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, $\mathbb{Z}_n$ 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: $\mathbb{Z}_p$, $\mathbb{Q}$, $\mathbb{R}$, and $\mathbb{C}$. Field of rational functions.

Books Recommended


**Core 4.2: Design and Analysis of 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.


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**


SEC 1.1: Logic and Sets

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


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


SEC 1.2: Analytical Geometry


Books Recommended

**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:**


SEC 2.1: Vector Calculus


Books Recommended

SEC 2.2: Transportation and Game Theory


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

Books Recommended


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


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


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


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


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


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


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


**DSE 1A.1: Matrices**

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.


**Books Recommended**


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

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


DSE 2A.1: Operating Systems


Books Recommended


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


DSE 2A.3: Cryptography


Book Recommended


DSE 1B.1: Difference Equations


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.


Books Recommended


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.


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


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


DSE 2B.1: Information Security


Books Recommended


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 (JavaScript/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

Books Recommended


5. Marty Hall, Larry Brown, and Yaakov Chaikin, Core Servlets and Java Server Pages: Core

DSE 2B.3: Computer Networks


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


