Test Code : CSB (Short Answer Type) 2017

Junior Research Fellowship (*JRF) in Computer Science*

The CSB test booklet will have two groups as follows:

GROUP A

A test of aptitude for Computer Science for all candidates in the basics of computer programming and mathematics, as indicated in the syllabus.

GROUP B

A test, divided into five sections in the following areas at M.Sc./M.E./M.Tech. level:

- Mathematics,
- Statistics,
- Physics,
- Electrical and Electronics Engineering, and
- Computer Science.

A candidate has to answer questions from **only** one of these sections in GROUP B, according to his/her choice.

Group A carries **40 marks** *and Group B carries* **60 marks**.

The syllabi and sample questions of the CSB test are given overleaf.

Syllabi

GROUP A:

Analytical reasoning.

Basics of programming (using pseudo-code), elementary data structures (array, stack and queue).

Basics of Set Theory, functions and relations.

Basic combinatorics: basic counting, inclusion-exclusion principle, pigeonhole principle.

Basic probability theory including conditional probability, Binomial distribution.

GROUP B:

Mathematics:

Graph theory and combinatorics: Graphs, paths and cycles, trees, Eulerian graphs, Hamiltonian graphs, chromatic numbers, planar graphs, digraphs and tournaments.

Linear algebra: Vector spaces, basis and dimension, orthogonality, linear transformations, matrices, rank, inverse, determinant, systems of linear equations, eigenvalues and eigenvectors, Cayley-Hamilton theorem, canonical forms, quadratic forms.

Abstract algebra: Groups, subgroups, products, cosets, Lagranges Theorem, group homomorphism, normal subgroups and quotient groups, permutation groups, Sylow theorems, rings, subrings, ring homomorphism, ideals and quotient rings, prime and maximal ideals, products, Chinese remainder theorem, integral domains, Prime and irreducible elements, fields, characteristic of a field, polynomial rings, division algorithm, roots of polynomials, principal ideal domain, unique factorization domains, field extensions, finite fields.

Elementary number theory: Elementary number theory, divisibility, congruences, primality.

Calculus and real analysis: Real numbers, convergence of sequences and

series, limits, continuity, uniform continuity of functions, differentiability of functions, indefinite integral, fundamental theorem of integral calculus, Riemann integration, improper integrals, sequences and series of functions, convergence.

Statistics:

Probability theory and distributions: Basic probability theory, discrete and continuous distributions, moments, characteristic functions, Markov chains.

Estimation and inference: Unbiased estimation, maximum likelihood estimation, sufficiency, completeness, consistency of estimates, most powerful and uniformly most powerful tests, unbiased tests and uniformly most powerful unbiased tests, confidence sets, Bayesian methods.

Linear models: Gauss-Markov set up and least squares theory, multiple linear regression, one and two way analysis of variance.

Multivariate analysis: Multiple and canonical correlations, multivariate normal distribution, principal component analysis, discriminant analysis.

Physics:

Classical mechanics: Lagrangian and Hamiltonian formulation of Newtonian mechanics, symmetries and conservation laws, motion in central field of force, small oscillations and normal modes, wave motion, special theory of relativity.

Electrodynamics: Electrostatics and magnetostatics, electric and magnetic phenomena in dielectrics, Maxwell's equations, conservation laws, electromagnetic waves, optics.

Thermodynamics and statistical physics: Laws of thermodynamics, statistical basis of thermodynamics, thermodynamic potentials and Maxwell's relations, density matrix formulation, ensembles, partition function, classical and quantum statistics, blackbody radiation and Planck's distribution law.

Quantum physics: Basic postulates of quantum mechanics, Schrodinger equation, Exactly solvable Eigenvalue problems: Particle in a box, Potential well, Harmonic oscillator, Matrix mechanics: Creation and annihilation operators, Angular momentum algebra, Spin, Symmetries and conservation laws, Quantum particle in electromagnetic field.

Atomic and nuclear physics: Energy spectrum of an electron in hydrogen atom, electron spin, relativistic correction, selection rules, Zeeman effect, Stark effect, basic nuclear properties, nuclear force, nuclear models, radioactive decays.

Electronics: Basics of semiconductor physics, transistors, amplifiers including feedback, oscillators, operational amplifiers, RLC circuits, digital integrated circuits, A/D and D/A converters.

Electrical and Electronics Engineering:

Digital circuits and systems: Gates and logic circuits, combinational and sequential circuits, A/D and D/A converters.

Circuit theory: Kirchoff's laws, theorem of superposition, Thevenin's theorem, Norton's theorem, A.C. circuits, Star-delta conversion.

Linear electronic devices and circuits: Diodes, Transistors, amplifiers including feedback amplifiers, oscillators, operational amplifiers.

Digital communication: Information and coding theory, concept of entropy, elementary error-detecting and error-correcting codes, Digital modulation techniques.

Digital signal processing: Sampling, linear time invariant systems, Z-transform, Fourier transform, Laplace transform.

Electrical machines: DC motors and generators, transformers, induction motors.

Computer Science:

Discrete mathematics: Functions and relations, Order notation, recurrence relations, generating functions, graph theory - paths and cycles, trees, digraphs, planar graphs, Eulerian graphs, Hamiltonian paths.

Programming languages: Fundamental concepts - abstract data types, procedure call and parameter passing, C language.

Data structures and design and analysis of algorithms: Linked list, queue, binary tree, heap, AVL tree, sorting, selection, searching, hashing, graph algorithms.

Computer organization and architecture: Number representation, computer arithmetic, memory organization, I/O organization, pipelining.

Operating systems: Process concept and management, scheduling, process synchronization, concurrency control, critical section problems, deadlocks, memory management, file systems.

Formal languages and automata theory: Finite automata and regular expressions, context-free grammars, Turing machines, undecidability.

Database management systems: Relational model, relational algebra, relational calculus, functional dependency, normalization (including multivalued dependencies), query processing and optimization.

Computer networks: Layered network structures, network security, LAN technology - bus/tree, ring, star; data communications - data encoding, flow control, error detection/correction.