Test Code: PCB (short answer type) 2017

M.Tech. in Computer Science

The selection test for M.Tech. in Computer Science will consist of two parts.

- Test **MMA** (objective type) in the forenoon session is the 1^{st} part, and
- Test **PCB** (short answer type) in the afternoon session is the 2^{nd} part.

  The **PCB** test will consist of two groups.

  ♢ **Group A** (30 Marks) : All candidates have to answer questions on analytical ability and mathematics at the undergraduate level.

  ♢ **Group B** (70 Marks) : A candidate has *to choose exactly one of the following five sections*, from which questions have to be answered:
  (i) Mathematics, (ii) Statistics, (iii) Physics, (iv) Computer Science, and (v) Engineering and Technology.
  While questions in the first three sections will be at postgraduate level, those for the last two sections will be at B.Tech. level.

The syllabus and sample questions for the **MMA** test are available separately. The syllabus and sample questions for the **PCB** test are given below.

Note:

1. Not all questions in this sample set are of equal difficulty. They may not carry equal marks in the test. More sample questions are available on the website for M.Tech(CS) at *http://www.isical.ac.in/~deanweb/MTECHCSSQ.html*
2. Each of the two tests **MMA** and **PCB**, will have individual qualifying marks.

SYLLABUS for Test PCB

Group A

Elementary Euclidean geometry and trigonometry.
Elements of set theory, Functions and relations, Permutations and combinations, Principle of inclusion and exclusion, Pigeon-hole principle.
Theory of equations, Inequalities.
Elementary number theory, divisibility, congruences, primality.
Determinants, matrices, solutions of linear equations, vector spaces, linear independence, dimension, rank and inverse.
Limits, continuity, sequences and series, differentiation and integration with applications, maxima-minima.

Group B

Mathematics

In addition to the syllabus for Mathematics in Group A, the syllabus includes:

Linear algebra – vector spaces and linear transformations, direct sum, matrices and systems of linear equations, characteristic roots and characteristic vectors, Cayley-Hamilton theorem, diagonalization and triangular forms, quadratic forms.

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

Calculus and real analysis – real numbers, limits, continuity, uniform continuity of functions, differentiability of functions of one or more variables and applications, convergence of sequences and series; indefinite integral, fundamental theorem of Calculus, Riemann integration, improper integrals, double and multiple integrals and applications, sequences and series of functions, uniform convergence, solutions of ordinary differential equations.

Graph Theory – connectedness, trees, vertex coloring, planar graphs, Eulerian graphs, Hamiltonian graphs, digraphs and tournaments.

Statistics

Notions of sample space and probability, combinatorial probability, conditional probability, Bayes' theorem and independence.
Random variable and expectation, moments, standard univariate discrete and continuous distributions, sampling distribution of statistics based on normal samples, central limit theorem, approximation of binomial to normal, Poisson law.
Multinomial, bivariate normal and multivariate normal distributions.
Descriptive statistical measures, product-moment correlation, partial and multiple correlation.
Regression – simple and multiple.
Elementary theory and methods of estimation – unbiasedness, minimum variance, sufficiency, maximum likelihood method, method of moments, least squares methods.
Tests of hypotheses – basic concepts and simple applications of Neyman-Pearson lemma, confidence intervals.
Tests of regression, elements of non-parametric inference, contingency tables and Chi-square, ANOVA, basic designs (CRD/RBD/LSD) and their analyses, elements of factorial designs.
Conventional sampling techniques, ratio and regression methods of estimation.

Physics

Classical mechanics – Lagrangian and Hamiltonian formulation, symmetries and conservation laws, motion in central field of force, planetary motion, simple harmonic motion - damped, undamped and forced, special theory of relativity.
Electrodynamics – electrostatics, magnetostatics, electromagnetic induction, self and mutual inductance, capacitance, Maxwell's equation in free space.
Nonrelativistic quantum mechanics – Planck's law, photoelectric effect, Compton effect, wave-particle duality, Heisenberg's uncertainty principle, Schrodinger equation and applications.
Thermodynamics and statistical Physics – laws of thermodynamics and their consequences, thermodynamic potentials and Maxwell's relations, chemical potential, phase equilibrium, phase space, microstates and macrostates, partition function, free energy, classical statistics.
Atomic and molecular physics – quantum states of an electron in an atom, Hydrogen atom spectrum, electron spin, spin-orbit coupling, fine structure, Zeeman effect.
Condensed matter physics – crystal classes, 2D and 3D lattice, reciprocal lattice, bonding, diffraction and structure factor, point defects and dislocations, lattice vibration, free electron theory, electron motion in periodic potential, energy bands in metals, insulators and semiconductors.
Basic nuclear physics – nuclear properties, nuclear forces, nuclear structures, nu-

clear reactions, radioactive nuclear decay.
Electronics – semiconductor physics; diodes - clipping, clamping, rectification; Zener regulated power supply, bipolar junction transistor - CC, CB, and CE configurations; transistor as a switch; amplifiers.
Operational Amplifier and its applications – inverting & noninverting amplifiers, adder, integrator, differentiator, waveform generator, comparator, Schmidt trigger.
Digital integrated circuits – NAND and NOR gates as building blocks, XOR gates, half and full adder.

Computer Science

Data structures - array, stack, queue, linked list, binary tree, heap, AVL tree, B-tree.
Discrete Mathematics - recurrence relations, generating functions, graph theory - paths and cycles, connected components, trees, digraphs.
Programming languages - Fundamental concepts - abstract data types, procedure call and parameter passing, dynamic memory allocation, C and C++.
Design and analysis of algorithms - Asymptotic notation, searching, sorting, selection, graph traversal, minimum spanning tree.
Switching Theory and Logic Design - Boolean algebra, minimization of Boolean functions, combinational and sequential circuits - synthesis and design.
Computer organization and architecture - Number representation, computer arithmetic, memory organization, I/O organization, microprogramming, pipelining, instruction level parallelism.
Operating systems - Memory management, processor management, critical section problem, deadlocks, device management, file systems.
Formal languages and automata theory - Finite automata and regular expressions, pushdown automata, context-free grammars, Turing machines, elements of undecidability.
Database management systems - Relational model, relational algebra, relational calculus, functional dependency, normalization (up to 3-rd normal form).
Computer networks - OSI, LAN technology - Bus/tree, Ring, Star; MAC protocols; WAN technology - circuit switching, packet switching; data communications - data encoding, routing, flow control, error detection/correction, Inter-networking, TCP/IP networking including IPv4.

Engineering and Technology

C Programming language.
Gravitation, moments of inertia, particle dynamics, elasticity, friction, strength of materials, surface tension and viscosity.
Laws of thermodynamics and heat engines.
Electrostatics, magnetostatics and electromagnetic induction.
Laws of electrical circuits – transient and steady state responses of resistive and

reactive circuits.
D.C. generators, D.C. motors, induction motors, alternators, transformers.
Diode circuits, bipolar junction transistors & FET devices and circuits, oscillator, operational amplifier.
Boolean algebra, Minimization of Boolean functions.
Combinatorial and sequential circuits – multiplexer, de-multiplexer, encoder, decoder, flip-flops, registers and counters, A/D and D/A converters.