Syllabus of the Descriptive Examination for Recruitment of Scientist 'B' in Computer Science

PAPER-I

1. Engineering Mathematics

a. Linear Algebra:
Matrices, Determinants, system of linear equations, eigenvalues and eigenvectors, LU decomposition, orthonormal bases, Transforms – Fourier, DCT, wavelets.

b. Calculus:
Limits, continuity, differentiability, maxima and minima, mean value theorem, integration. Vector calculus – gradient, divergence, curl, integral theorems.

c. Probability:
Random variables, probability distributions – uniform, normal, exponential, Poisson, binomial. Mean, median, mode, standard deviation. Conditional probability and Bayes theorem. Information theory: Shannon entropy, information, conditional information.

2. Discrete Mathematics:

Propositional and first order logic. Sets, relations, functions, partial orders and lattices, groups.
Graphs: connectivity, matching, coloring.
Combinatorics: counting, recurrence relations, generating functions

3. Digital Logic:

Boolean algebra. Combinational and sequential circuits. Minimization.
Number representation and computer arithmetic (fixed and floating point).

4. Computer Organization and Architecture

Machine instructions and addressing modes. Assembly language. ALU, data path and control unit. Instruction pipelining. Memory hierarchy: cache, main memory and secondary storage. I/O interface (interrupt and DMA modes). RISC, CISC, parallel architectures.

5. Programming and Data Structures

Programming in C: functions, structures, memory management, recursion, arrays, stacks, queues, linked lists, trees, binary search trees, binary heaps, graphs. Object oriented programming basics.

6. Algorithms

Searching, sorting, hashing. Asymptotic worst case, time and space complexity. Algorithm design techniques: greedy, dynamic programming and divide-and-conquer. Graph search, minimum spanning trees, shortest paths.

PAPER-II

1. Compiler design

Lexical analysis, parsing, syntax-directed translation.
Runtime environments, intermediate code generation.

2. Operating System

Processes, threads, inter-process communication, concurrency and synchronization, deadlocks. CPU scheduling. Memory management and virtual memory. File systems. Virtual machines and hypervisors. Secure operating systems.

3. **Theory of Computation**
Regular expressions and finite automata. Context-free grammars and push-down automata. Regular and context-free languages, pumping lemma. Turing machines and undecidability.

4. **Databases**
ER-model. Relational model: relational algebra, tuple calculus, SQL. Integrity constraints. Normal forms. File organization, indexing (eg, B and B+ trees). Transactions and concurrency controls.

5. **Computer Networks**
Concept of layering, OSI model. LAN technologies (Ethernet). Flow and error control techniques, switching. IPv4 / IPv6, routers and routing algorithms (distance vector, link state). TCP/UDP and sockets, congestion control. Application layer protocols (DNS, SMTP, POP, FTP, HTTP). Basics of WiFi.

6. **Security of Cyber Systems**
Cyber security principles, Kerberos, RADIUS, secure protocols (IPSec, SSH, SSL), basics of public key and private key cryptography, hash functions, block chains, digital signatures, certificates.
Firewalls, intrusion detection systems, basics of IoT security and Cloud security.
Threats, vulnerabilities, malicious software. Attacks: buffer overflow, DoS, DDoS, SQL injection, web application attacks

7. **AI and Machine Learning**
Classification and clustering techniques, dimensionality reduction: PCA, SVD. Correlation and regression analysis. Training and test data: over fitting, under fitting. Search. Ontology. Decision trees. Artificial Neural networks: activation function, multi-layer perceptron, deep learning.
Application of artificial neural networks.