GATE Syllabus for CS and DA

1. Operating System

- System calls, processes, threads
- Inter-process communication
- Concurrency, and synchronization
- Deadlock handling
- CPU and I/O scheduling
- Memory management, paging, segmentation, virtual memory
- File systems

2. Digital Logic

- Boolean algebra
- Combinational and sequential circuits
- Minimization techniques (K-map, Quine–McCluskey)
- Number system and representations
- Computer arithmetic (fixed and floating point)

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. Programming and Data Structures

- Programming in C and Python
- Recursion, search algorithms (linear, binary)
- Arrays, stacks, queues, linked lists, trees, hash tables
- Binary search trees, binary heaps, graphs

5. Algorithms

- Searching, sorting, hashing
- Sorting algorithms: selection, bubble, insertion, merge, quicksort
- Asymptotic time and space complexity
- Algorithm design techniques: greedy, dynamic programming, divide-and-conquer
- Graph theory: basic concepts, traversals, shortest path, minimum spanning trees
- Hashing techniques

6. Computer Organization and Architecture

- Machine instructions and addressing modes
- ALU, data path, and control unit
- Instruction pipelining and pipeline hazards
- Memory hierarchy: cache, main memory, secondary storage
- I/O interface (interrupt and DMA mode)

7. Compiler Design

- Lexical analysis, parsing
- Syntax-directed translation
- Runtime environments
- Intermediate code generation
- Local optimization
- Data flow analyses (constant propagation, liveness analysis, common subexpression elimination)

8. Databases & Data Warehousing

- ER-model
- Relational model: relational algebra, tuple calculus, SQL
- Integrity constraints, normalization (normal forms)
- File organization, indexing (e.g., B and B+ trees)
- Transactions and concurrency control
- Data types and transformations: normalization, discretization, sampling
- Data warehouse modeling: schemas, hierarchies, and measures

9. Computer Networks

- Network models: OSI and TCP/IP Protocol Stacks
- Switching techniques: packet, circuit, and virtual circuit switching
- Data link layer: framing, error detection, MAC, Ethernet
- Network layer: IP addressing (IPv4, CIDR), fragmentation, ARP, DHCP, ICMP, NAT
- Routing algorithms: shortest path, flooding, distance vector, link state
- Transport layer: TCP, UDP, sockets, flow & congestion control
- Application protocols: DNS, SMTP, HTTP, FTP, Email

10. Artificial Intelligence

- Search algorithms: uninformed, informed (A*, greedy), adversarial (minimax, alpha-beta pruning)
- Logic: propositional and predicate
- Reasoning under uncertainty: conditional independence, exact inference (variable elimination), approximate inference (sampling)

11. Machine Learning

- Supervised Learning
  - Regression: linear, multiple, logistic, ridge
  - Classification: k-NN, Naive Bayes, LDA, SVM, decision trees
  - Neural networks: MLP, feed-forward
  - Evaluation: bias-variance trade-off, cross-validation (k-fold, leave-one-out)
- Unsupervised Learning
  - Clustering: k-means, k-medoids, hierarchical (top-down, bottom-up)
  - Dimensionality reduction: PCA

12. Engineering Mathematics:

- Discrete Mathematics:
  - Propositional and first-order logic
  - Sets, relations, functions
  - Partial orders and lattices
  - Monoids and groups
  - Graphs: connectivity, matching, coloring, traversals, shortest path
  - Combinatorics: permutations, combinations, counting, recurrence relations, generating functions
- Linear Algebra:
  - Vector spaces, subspaces
  - Linear dependence and independence
  - Matrices: projection, orthogonal, idempotent, partition
  - Determinant, rank, nullity
  - System of linear equations, Gaussian elimination
  - LU decomposition, SVD (Singular Value Decomposition)
  - Eigenvalues and eigenvectors
  - Projections, quadratic forms
- Calculus and Optimization:
  - Functions of a single variable
  - Limits, continuity, and differentiability
  - Taylor series
  - Maxima and minima
  - Mean value theorem
  - Optimization with single variable
  - Integration
- Probability and Statistics:
  - Sample space, events, axioms
  - Independent and mutually exclusive events
  - Random variables (discrete & continuous)
  - PMF, PDF, CDF
  - Conditional, marginal, and joint probabilities
  - Bayes' theorem, conditional expectation and variance
  - Mean, median, mode, standard deviation
  - Correlation, covariance
  - Distributions: uniform, normal, standard normal, exponential, Poisson, binomial, t-distribution, chi-squared
  - Central Limit Theorem
  - Confidence intervals
  - Hypothesis testing: z-test, t-test, chi-squared test

13. General Aptitude: Verbal Aptitude, Quantitative Aptitude, Analytical Aptitude, Spatial Aptitude