

The Ultimate Internship Preparation Master Roadmap

100% Atomic Checklist for Technical OA and Interview Excellence

The Strategy: The 70/30 Split

- 70% of your daily time:** Track A (Math & DSA). This is a continuous, daily marathon. Do not stop coding.
 - 30% of your daily time:** Track B (Core CS & System Design). Study OS, DBMS, Networks, and COA in parallel.
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PHASE 1: The Non-Negotiable Core (90% Focus)

Track A: Algorithmic Math, Language Fluency & DSA

Algorithmic Math & Logic

- Propositional Logic
- Truth Tables
- Predicate Logic
- Set Theory
- Injective Functions
- Surjective Functions
- Mathematical Induction
- Pigeonhole Principle
- Permutations
- Combinations
- Binomial Coefficients
- Recurrence Relations
- Inclusion-Exclusion
- Equivalence Relations
- Partial Orders
- Group Theory Basics
- Greatest Common Divisor
- Sieve of Eratosthenes
- Bit Manipulation tricks

Language Fluency

- Variables
- Data Types
- Loops
- Conditionals
- Functions
- Memory references
- Pointers
- Mutability
- Classes
- Objects
- Inheritance
- Polymorphism
- Encapsulation
- Abstraction

Asymptotic Analysis

- Big-O Notation
- Big-Omega Notation
- Big-Theta Notation
- Worst-case analysis
- Best-case analysis
- Average-case analysis
- Amortized analysis

Arrays & Hashing

Track A Resources:

- Interactive:** NeetCode.io, Educative.io (Grokking).

- Array traversal
- Array manipulation
- Hash Maps
- Hash Sets
- Prefix Sums
- Hash collisions
- Open hashing (Chaining)
- Closed hashing (Probing)

Sorting Algorithms

- Bubble sort
- Selection sort
- Insertion sort
- Merge sort
- Quick sort
- Randomized Quick sort
- Counting sort
- Radix sort
- Lower bound for comparison

Two Pointers & Windows

- Two Pointers (opposite ends)
- Two Pointers (same direction)
- Fixed Sliding Window
- Dynamic Sliding Window

Stacks, Queues & Lists

- Singly Linked Lists
- Doubly Linked Lists
- Circular Linked Lists
- List Reversal techniques
- Fast Pointers
- Slow Pointers
- Cycle Detection
- LIFO principles
- FIFO principles
- Monotonic Stacks
- Parenthesis matching
- Prefix evaluation
- Postfix evaluation

Trees & Binary Search

- Binary Search algorithm
- Binary Search on Answer
- Inorder Traversal
- Preorder Traversal
- Postorder Traversal
- Level-Order Traversal

- BST properties
- Lowest Common Ancestor
- AVL trees
- Red-black trees
- B-trees
- Splay trees
- Multi-way search trees

Advanced DS & Geometry

- Trie Insert
- Trie Search
- Trie StartsWith
- Suffix trees
- Bloom filters
- Min-Heap
- Max-Heap
- Priority Queues
- Disjoint Sets (Union-Find)
- Union-by-rank
- Path-compression
- Convex hull
- Range-trees
- k-d trees
- Boyer-Moore algorithm
- Rabin-Karp algorithm
- KMP algorithm

Graphs

- Adjacency List
- Adjacency Matrix
- Breadth-First Search
- Depth-First Search
- Topological Sort
- Strongly Connected Components
- Dijkstra's algorithm
- Kruskal's algorithm
- Prim's algorithm
- Network flows
- Max-flow min-cut

Dynamic Programming

- Backtracking (Subsets)
- Backtracking (Permutations)
- Backtracking (Combinations)
- 1D DP Memoization
- 1D DP Tabulation
- 2D DP Grid travel
- 2D DP Knapsack

- Books:** Discrete Mathematics and Its Applications (Rosen), Algorithm Design (Kleinberg/Tardos), Introduction to Algorithms (Cormen), Grokking Algorithms (Bhargava).
 - YouTube:** NeetCode, Abdul Bari, WilliamFiset, MIT OpenCourseWare.
 - Practice:** LeetCode, Codeforces, AtCoder, HackerRank.
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Track B: Core CS, Architecture & System Design

Computer Architecture (COA)

- CPU Organization
- Data Representation
- Instruction Sets
- Datapath design
- ALU design
- Hardwired control
- Micro-programmed control
- Cache memory mapping
- Programmed I/O
- Interrupt controlled I/O
- DMA controller
- Pipelining principles

Operating Systems (OS)

- Interrupt Sources
- Interrupt Priorities
- Interrupt Service Routines
- Process Control Block
- Process States
- Context Switching
- Inter-Process Communication
- User-level threads
- Kernel-level threads
- Preemptive scheduling
- Non-Preemptive scheduling
- FCFS Scheduling
- SJF Scheduling
- SRTF Scheduling
- Round Robin Scheduling
- Priority Scheduling
- Storage Hierarchy
- Contiguous Memory
- Paging
- Segmentation
- Virtual Memory
- Page Faults
- TLB (Translation Lookaside)
- Page Replacement (FIFO)
- Page Replacement (LRU)
- Page Replacement (Optimal)
- Thrashing
- Disk Structure
- Disk Scheduling (SCAN)
- Disk Scheduling (SSTF)
- File System Organization
- File Allocation
- Inodes
- Race Conditions
- Critical Section
- Mutexes
- Semaphores
- Monitors
- Deadlock Prevention
- Deadlock Avoidance
- Deadlock Detection

- Deadlock Recovery
- Distributed Architectures
- Clock Synchronization
- Distributed Mutual Exclusion
- Election Algorithms
- Distributed Deadlocks
- Mobile OS Architectures
- Power Management
- Linux Kernel Configuration
- Linux Kernel Compilation
- Char Device Drivers
- Block Device Drivers
- Network Device Drivers

Database Management (DBMS)

- ER Modeling
- EER Modeling
- Relational Algebra Selection
- Relational Algebra Projection
- Relational Algebra Join
- Primary Keys
- Foreign Keys
- Candidate Keys
- Super Keys
- Update Anomalies
- Insertion Anomalies
- Deletion Anomalies
- 1NF
- 2NF
- 3NF
- BCNF
- Procedural Query Languages
- Non-procedural Query Languages
- Query Processing
- SQL SELECT
- SQL INSERT
- SQL UPDATE
- SQL DELETE
- SQL INNER JOIN
- SQL LEFT JOIN
- SQL RIGHT JOIN
- SQL FULL OUTER JOIN
- SQL GROUP BY
- SQL HAVING
- SQL Subqueries
- Window Functions (RANK)
- Window Functions (ROW)
- Storage organization
- ACID Atomicity
- ACID Consistency
- ACID Isolation
- ACID Durability
- Write-Ahead Logging
- Database Recovery
- Isolation Read Uncommitted
- Isolation Read Committed
- Isolation Repeatable Read

- Isolation Serializable
- Two-Phase Locking
- Dense Indexes
- Sparse Indexes
- B-Trees indexing
- B+ Trees indexing

Computer Networks

- Signaling Schemes
- Encoding
- Modulation
- Bit Stuffing
- Byte Stuffing
- Character Stuffing
- Switching Techniques
- OSI 7-Layer Model
- TCP/IP Layer Model
- MAC Addresses
- Error Detection
- Error Correction
- Address Resolution Protocol
- CSMA/CD
- Hubs
- Switches
- Routers
- IPv4 Addressing
- IPv6 Addressing
- Subnetting
- CIDR
- Network Address Translation
- ICMP
- Distance Vector Routing
- Link State Routing
- OSPF
- BGP
- Multiplexing
- Demultiplexing
- Transmission Control Protocol
- User Datagram Protocol
- TCP 3-Way Handshake
- TCP Connection Teardown
- TCP Slow Start
- TCP Congestion Avoidance
- Domain Name System
- HTTP
- HTTPS
- REST APIs
- WebSockets
- SMTP
- FTP
- Email Architecture
- Multimedia Networking

System Design

- SOLID Principles
- Singleton Pattern
- Factory Pattern

- Observer Pattern
- Strategy Pattern
- Horizontal Scaling
- Vertical Scaling
- Load Balancing
- Consistent Hashing
- Database Sharding
- Caching Strategies
- Redis Basics
- Memcached Basics
- CAP Theorem
- Microservices Architecture
- Monolithic Architecture
- Message Queues
- Kafka Basics
- RabbitMQ Basics
- API Gateways

Track B Resources:

- Interactive:** SQLBolt (DBMS), Select Star SQL (DBMS), Educative.io (OS, Networks, System Design).
 - Books:** OSTEP (OS), Database System Concepts (Silberschatz), Computer Networking (Kurose/Ross), Computer Architecture (Hennessy/Patterson), Designing Data-Intensive Applications (Kleppmann).
 - YouTube:** Neso Academy (OS), Hussein Nasser (DBMS), PowerCert Animated Videos (Networks), ByteByteGo (Sys Design), Gate Smashers.
 - Practice:** GeeksforGeeks Mock Tests, LeetCode SQL 50, StrataScratch.
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PHASE 2: The Edge Tracks (Domain Specific)

Web Development

- Web System Architecture
- Web Clients
- Web Servers
- Application Servers
- HTTP Primitives
- HTTP Methods
- HTTP1.1
- HTTP2
- HTTPS
- SSL
- HTML5
- CSS3
- XHTML
- DOM manipulation
- JavaScript Event logic
- Client-side validation
- Promises
- Async-Await
- Server-side Sessions
- Session Tracking
- XML Syntax
- XML DTD
- XML Namespaces
- XML Schemas
- XPath
- XSLT
- jQuery basics
- AJAX basics
- Web Frameworks
- Search Engines
- Search Engine Optimization
- Semantic Web

- React Components
- React State
- React Props
- Node.js basics
- Express.js basics

AI & ML

- Pandas DataFrames
- Pandas Grouping
- Pandas Cleaning
- Feature Scaling
- Categorical Encoding
- NumPy Vectorization
- NumPy Matrix Math
- Linear Regression
- Logistic Regression
- Decision Trees
- Support Vector Machines
- K-Nearest Neighbors
- K-Means Clustering
- Principal Component Analysis
- Train/Test Splits
- Cross-Validation
- Precision Evaluation
- Recall Evaluation
- F1 Score Evaluation
- ROC-AUC Metric
- Perceptrons
- Activation Functions
- Backpropagation
- Loss Functions

DevOps

- Git Trees

- Git Blobs
- Git Commits
- GitFlow Branching
- Git Merging
- Git Rebasing
- Git Conflict Resolution
- Linux Navigation
- Linux Permissions
- Bash Scripting
- Cron Jobs
- Nginx Basics
- Reverse Proxies
- Load Balancing concepts
- Docker Daemon
- Docker Architecture
- Writing Dockerfiles
- Docker Compose
- Docker Volumes
- CI/CD Pipelines
- GitHub Actions

Cybersecurity

- CIA Triad
- Symmetric Cryptography
- Asymmetric Cryptography
- Hashing concepts
- Encryption concepts
- OWASP Top 10
- SQL Injection
- Cross-Site Scripting
- CSRF Vulnerabilities
- Penetration Testing
- Nmap Port Scanning
- Wireshark Packet Sniffing

Edge Track Resources:

- Interactive:** FreeCodeCamp (Web), Scrimba (Web), Kaggle Learn (AI/ML), KodeKloud (DevOps), KillerCoda (DevOps), TryHackMe (Security), HackTheBox (Security).
 - Books:** Programming the World Wide Web (Sebesta), Hands-On Machine Learning (Géron), Docker Deep Dive (Poulton), The Web Application Hacker's Handbook.
 - YouTube:** Fireship (Web), StatQuest (AI/ML), TechWorld with Nana (DevOps), NetworkChuck (Security), John Hammond (Security).
 - Practice:** Frontend Mentor (Web), Kaggle Competitions (ML), AWS/GCP Free Tier Labs (DevOps), OverTheWire (Security).
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PHASE 3: Behavioral & Mock Interviews

Communication

- STAR Method Situation
- STAR Method Task
- STAR Method Action
- STAR Method Result
- Elevator Pitch creation
- Resume tech stack defense

- Conflict Resolution Story
- Project Failure Story
- Teamwork & Leadership Story

Mock Strategy

- Think Out Loud practice
- Time management pacing

- Clarifying questions practice
- Edge case identification

Simulated Platforms

- LeetCode Weekly Contests
- Pramp Peer Mock Interviews
- Interviewing.io (Observation)