



Koneru Lakshmaiah Education Foundation

(Category -1, Deemed to be University estd. u/s. 3 of the UGC Act, 1956)

◆ Approved by AICTE ◆ ISO 21001:2018 Certified

Campus: Green Fields, Vaddeswaram - 522 302, Guntur District, Andhra Pradesh, INDIA.

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Department of Master of Computer Applications

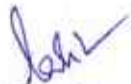
Course Outcomes 2026-2027

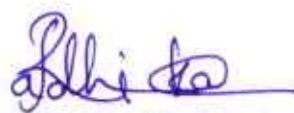
S.No	Course Code	Course Title	CO. No	Course Outcome
1	26CA5101E	PYTHON PROGRAMMING I — FOUNDATIONS & OOP	CO1	Apply Python language fundamentals — types, control flow, functions, and standard data structures (list / tuple / dict / set) — to solve algorithmic problems and build small command-line utilities.
			CO2	Apply object-oriented design principles — classes, encapsulation, inheritance, polymorphism, dunder methods, and dataclasses — to model domain entities for application-domain problems.
			CO3	Analyze module structure, packaging, virtual environments (venv / poetry), and dependency management to design maintainable, distributable Python applications.
			CO4	Analyze exception handling pathways, file I/O patterns (text / JSON / CSV / SQLite), and standard library usage to build robust scripts and reliable persistence layers.
			CO5	Evaluate code quality and design choices to refactor solutions using idiomatic Python — comprehensions, generators, decorators, context managers — for readability, performance, and Pythonic style.
			CO6	Evaluate the integration of testing (pytest), version control (Git / GitHub), and AI-assisted coding (GitHub Copilot, Claude Code) into a complete project deliverable, including CI workflows on GitHub Actions.


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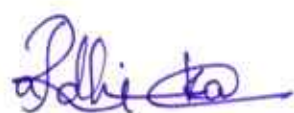
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2	26CA5102E	LINUX & OPERATING SYSTEM ADMINISTRATION	CO1	Apply Linux command-line tools, file system semantics, and process management to perform day-to-day system administration tasks confidently.
			CO2	Apply shell scripting (Bash) with control flow, functions, and standard utilities (awk, sed, grep, find, xargs) to automate operational tasks.
			CO3	Analyze user, group, and permission models (DAC + ACLs + capabilities + SELinux) to design least-privilege access for multi-tenant systems.
			CO4	Analyze service management with systemd, networking with ip/ss/firewalld, and storage with LVM/RAID to diagnose runtime failures.
			CO5	Evaluate hardening choices (kernel parameters, SSH policy, file integrity monitoring, audit logging) to design a CIS-benchmark-aligned baseline.
			CO6	Evaluate fleet automation (Ansible) and observability (logs, metrics, traces) to design and ship a managed Linux infrastructure deliverable.
3	26CA5103E	DATABASE & DISTRIBUTED DATABASE ADMINISTRATION	CO1	Apply relational design principles (normalization, ER modelling, SQL DDL/DML) to build well-structured PostgreSQL schemas for application domains.
			CO2	Analyze SQL execution plans (EXPLAIN ANALYZE), index strategies (B-tree, hash, GiST, GIN), and statistics to optimize slow queries.
			CO3	Apply NoSQL document design (MongoDB) — schema patterns, embedding vs referencing, indexing, aggregation pipelines — to model semi-structured data.
			CO4	Analyze ACID semantics, isolation levels, MVCC, and locking to diagnose concurrency issues in transactional


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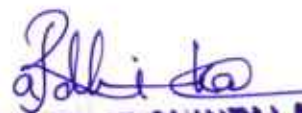
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				workloads.
			CO5	Evaluate distribution strategies — replication, sharding, partitioning, CAP trade-offs — to design highly-available database architectures.
			CO6	Evaluate operational practices — backup/restore, point-in-time recovery, monitoring, security — to ship a production-ready database deployment.
4	26CA5104E	CLOUD ADMINISTRATION & CLOUD DEVOPS	CO1	Apply cloud computing fundamentals and AWS core services (EC2, S3, VPC, IAM, RDS) to provision a multi-tier application.
			CO2	Apply Infrastructure as Code with Terraform — providers, modules, state, workspaces — to manage cloud resources reproducibly.
			CO3	Analyze CI/CD pipeline patterns (GitHub Actions, GitLab CI) to design end-to-end deployment workflows with quality gates.
			CO4	Apply containerization (Docker) and orchestration fundamentals (ECS, Kubernetes basics) to deploy scalable applications.
			CO5	Evaluate observability strategies — logging, metrics, tracing, alerting — to design production-grade monitoring.
			CO6	Evaluate cost, security, and reliability trade-offs in cloud architectures to design well-architected workloads.
5	26UC5103E	PROFESSIONAL COMMUNICATION & MATHEMATICAL METHODS	CO1	Apply technical writing principles — clarity, structure, audience-awareness — to produce design docs, READMEs, runbooks, and incident reports of professional quality.
			CO2	Apply spoken communication skills — technical presentation, code walkthrough, lightning talks, stakeholder briefings — including handling Q&A and interview-style explanations.


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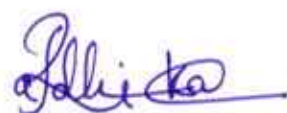
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6	26CA5205E	PYTHON PROGRAMMING II — DSA & PROBLEM SOLVING	CO3	Apply linear algebra fundamentals — vectors, matrices, eigenvalues, SVD — needed across ML, computer graphics, cryptography, and HPC.
			CO4	Apply probability & statistics fundamentals — random variables, distributions, expectation, variance, conditional probability, Bayes' theorem — needed for ML and analytics.
			CO5	Analyze discrete mathematics topics — sets, logic, graphs, combinatorics, number theory — needed for algorithms, cryptography, and database theory.
			CO6	Apply soft-skill workplace competencies — meeting hygiene, written async communication, async-first collaboration, conflict resolution, code-review etiquette.
			CO1	Apply linear data structures (arrays, linked lists, stacks, queues, deques) implemented in Python to solve common engineering problems.
			CO2	Analyze tree structures (BST, AVL, heaps, tries) and graph representations (adjacency list/matrix) to choose the right structure per problem.
			CO3	Analyze sorting and searching algorithms — quicksort, mergesort, heapsort, binary search variants — for correctness and asymptotic complexity.
			CO4	Analyze graph algorithms (BFS, DFS, Dijkstra, Bellman-Ford, MST, topological sort) and their real-world applications.
			CO5	Evaluate dynamic programming, greedy, and backtracking strategies to design efficient solutions for combinatorial problems.
			CO6	Evaluate algorithm performance via


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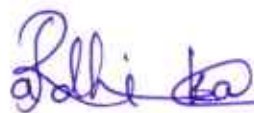
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				empirical benchmarking and profile-driven optimization in Python.
7	26CA5206E	FULL STACK DEVELOPMENT I — PYTHON WEB & DATABASE	CO1	Apply HTTP fundamentals, HTML5, CSS3, and modern JavaScript (ES6+) to build accessible, responsive frontends.
			CO2	Apply Python web frameworks (Flask & Django) — routing, views, templates, forms, sessions — to build full-featured web applications.
			CO3	Analyze ORM patterns (SQLAlchemy & Django ORM) and database migrations to design clean data layers.
			CO4	Apply REST API design principles (resources, methods, status codes, versioning) to build well-documented backend APIs.
			CO5	Analyze authentication & authorization patterns (sessions, JWT, OAuth) to implement secure user flows.
			CO6	Evaluate deployment strategies (gunicorn + nginx, Docker, cloud PaaS) to ship a production-ready web application.
8	26CA5207E	ARTIFICIAL INTELLIGENCE & MACHINE LEARNING	CO1	Apply pandas, NumPy, and scikit-learn for end-to-end ML workflows on tabular data.
			CO2	Apply supervised learning algorithms (regression, classification) to build predictive models.
			CO3	Analyze unsupervised techniques (clustering, dimensionality reduction) to discover structure in data.
			CO4	Analyze model evaluation metrics, cross-validation, and bias-variance trade-offs to diagnose model behavior.
			CO5	Evaluate feature engineering, hyperparameter tuning, and ensemble methods for high-performance models.
			CO6	Evaluate ML deployment patterns (REST API, batch scoring, monitoring) for production-ready solutions.


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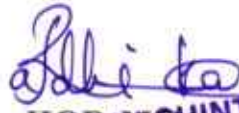
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9	26CA5208E	OFFENSIVE SECURITY & ETHICAL HACKING	CO1	Apply offensive security methodology (PTES, OWASP Testing Guide) to plan and scope pentesting engagements.
			CO2	Apply reconnaissance techniques — passive (OSINT) and active (port scanning, banner grabbing) — to map target attack surface.
			CO3	Analyze OWASP Top 10 web vulnerabilities (injection, XSS, IDOR, SSRF, broken auth) to identify and exploit them in test environments.
			CO4	Analyze network and system exploitation techniques — Metasploit, Mimikatz, privilege escalation paths — for authorized testing.
			CO5	Evaluate post-exploitation strategies — persistence, lateral movement, exfiltration — and the corresponding defensive controls.
			CO6	Evaluate findings, write professional pentest reports with risk ratings, and present remediation guidance to stakeholders.
10	26CA5309E	FULL STACK DEVELOPMENT II — FASTAPI · MONGODB · REACT	CO1	Apply FastAPI with Pydantic, async/await, dependency injection, and OpenAPI auto-docs to build modern Python APIs.
			CO2	Analyze async Python patterns (asyncio, async DB drivers) for high-throughput services.
			CO3	Apply MongoDB advanced features — aggregation, transactions, change streams, indexing.
			CO4	Apply React with hooks and modern state management (TanStack Query) to build SPAs.
			CO5	Analyze WebSocket and SSE patterns to design real-time collaborative apps
			CO6	Evaluate frontend deployment (CDN, edge, SSR with Next.js) to ship a production SPA.
11	26CA5310E	APPLIED DEEP LEARNING, LLM ENGINEERING & RAG	CO1	Apply PyTorch with autograd, optimizers, training loops to build


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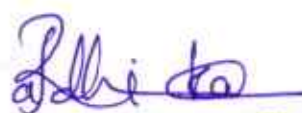
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				neural networks for vision and text.
			CO2	Analyze transformer architectures and pretrained models from Hugging Face for downstream tasks.
			CO3	Apply LLM API patterns — prompts, function-calling, structured output — using OpenAI, Anthropic, and OSS LLMs.
			CO4	Analyze RAG architecture — chunking, embeddings, vector search, reranking — for accurate Q&A.
			CO5	Evaluate RAG quality with frameworks (RAGAs, TruLens) and design retrieval improvements based on metrics.
			CO6	Evaluate fine-tuning options (LoRA, instruction tuning) vs prompting trade-offs for production LLM systems.
12	26CA5311E	HIGH PERFORMANCE COMPUTING & CLUSTER MANAGEMENT	CO1	Apply HPC architecture concepts (interconnects, NUMA, parallel filesystems) to understand cluster design.
			CO2	Apply parallel programming with OpenMP and MPI to write multi-threaded and multi-process code.
			CO3	Apply GPU programming with CUDA + PyTorch for accelerated numerical workloads.
			CO4	Analyze SLURM workload manager — partitions, jobs, queues, accounting — to operate shared HPC clusters.
			CO5	Analyze containerized HPC (Singularity/Apptainer, Kubernetes for ML) for portable scientific workloads.
			CO6	Evaluate scaling efficiency (strong vs weak scaling), performance bottlenecks, and tuning strategies for HPC apps.
13	26CA5312E	ADAPTIVE SOFTWARE ENGINEERING WITH MLOPS	CO1	Apply software engineering practices — clean architecture, design patterns, SOLID — to ML codebases.
			CO2	Apply experiment tracking, model versioning, and reproducibility patterns (MLflow, DVC, Weights &


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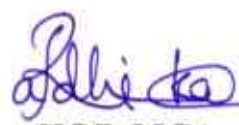
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				Biases).
			CO3	Analyze CI/CD for ML — testing models, data validation, model deployment pipelines.
			CO4	Apply feature stores, model registries, and inference servers for production ML.
			CO5	Evaluate model monitoring strategies — performance, data drift, concept drift — and automated retraining.
			CO6	Evaluate AI agents and self-improving systems for adaptive software design.
14	26CA6113E	GenAI API & AI Platform Eng	CO1	Apply production LLM API patterns — prompt versioning, prompt caching, batched inference, async + streaming, idempotency, retry with backoff — to build resilient GenAI services.
			CO2	Analyze multi-model orchestration patterns — model routing by cost/latency/quality, fallback chains, OSS vs commercial trade-offs, specialized models (code, embeddings, vision) — to design optimal cost-quality envelopes.
			CO3	Analyze GenAI safety threats and defenses — prompt injection, jailbreaks, data exfiltration, content moderation, PII detection & redaction, adversarial prompts — to harden production systems.
			CO4	Apply LLM observability — token usage, latency P50/P95/P99, cache hit rates, error rates, cost attribution per tenant — and eval-driven development with golden datasets.
			CO5	Evaluate AI gateway architectures (LiteLLM, Portkey, Kong AI Gateway) and multi-tenant patterns — quotas, rate limits per tenant, audit logging, encryption — for production-grade GenAI platforms.
			CO6	Evaluate compliance and governance frameworks — NIST AI RMF, EU AI Act,


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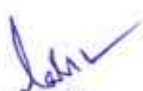

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				India's DPDP Act 2023, model cards, system cards, red-teaming reports — for responsible deployment of GenAI systems.
15	26CA6114E	Data Science, Analytics & Viz	CO1	Apply the analytics workflow — define metric, collect data, wrangle, analyze, visualize, present — to deliver a complete analytics deliverable for a real stakeholder question.
			CO2	Apply advanced SQL (window functions, CTEs, recursive queries, time-series rollups) and pandas (merge, melt, pivot, groupby/agg, multi-index) to wrangle large analytical datasets.
			CO3	Analyze data using inferential statistics — descriptive measures, hypothesis testing (t-test, chi-square, ANOVA), A/B-test design (sample size & power), regression for inference — to draw evidence-based conclusions.
			CO4	Analyze visualization grammar (the layered grammar of graphics) and modern tools (Tableau, Power BI, Plotly Express, Plotly Dash) to design accurate and informative charts.
			CO5	Evaluate dashboard design choices — information hierarchy, interactivity, drill-downs, narrative flow, mobile responsiveness — to ship a stakeholder-grade decision tool.
			CO6	Evaluate the analytics-to-action loop — turning insights into hypotheses, hypotheses into experiments, experiments into product decisions — and the common anti-patterns (vanity metrics, p-hacking, Simpson's paradox).
16	26CA6215E	Agentic AI + Full Stack + MCPs	CO1	Apply core agent patterns — ReAct, function-calling, planner/executor split, reflection, self-critique — using modern frameworks (Anthropic Agent SDK, LangGraph, AutoGen, CrewAI) to


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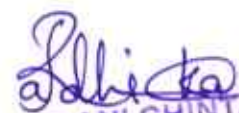
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				solve multi-step tasks.
			CO2	Analyze the Model Context Protocol (MCP) — server architecture, transports (stdio, HTTP+SSE), tools, resources, prompts — to design composable agent capabilities.
			CO3	Apply full-stack engineering for agentic apps — streaming UIs, tool-call rendering, async background jobs, persistent agent state, conversation memory — using FastAPI + React + WebSocket/SSE.
			CO4	Analyze multi-agent orchestration patterns — supervisor/worker, peer-to-peer, hierarchical teams, swarms — and their cost/latency/correctness trade-offs.
			CO5	Evaluate agent safety and reliability — sandboxing, capability scoping, tool-call auditing, prompt injection through tools, infinite-loop prevention, human-in-the-loop checkpoints.
			CO6	Evaluate agent observability and eval — trace completeness, step-by-step replay, LLM-as-judge for reasoning chains, agentic-eval frameworks (LangSmith, Braintrust, AgentBench).
17	26CA6216E	Blockchain & Smart Contract Prog	CO1	Apply blockchain fundamentals — distributed ledgers, consensus mechanisms (PoW, PoS, PBFT), Merkle trees, hash functions, asymmetric cryptography & signatures — to reason about transactional integrity in decentralized systems.
			CO2	Analyze the EVM execution model — gas, opcodes, storage layout, calldata, message calls, delegatecall — to write efficient and correct smart-contract bytecode.
			CO3	Apply Solidity (and Vyper) language idioms — types, mappings, structs, modifiers, events, errors, libraries — to build smart contracts following


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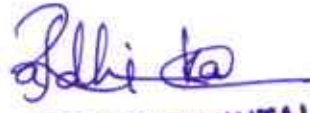
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18	26CA6217E	Defensive Security		community style guides.
			CO4	Apply Hardhat / Foundry development frameworks for testing (forge test), gas profiling, fuzzing, and local-network deployment with Anvil.
			CO5	Analyze ERC token standards (ERC-20, ERC-721, ERC-1155, ERC-4626) and DeFi primitives (AMM, lending, staking, yield) to compose production protocols.
			CO6	Evaluate smart-contract security — reentrancy, integer over/underflow, oracle manipulation, signature replay, MEV, access-control flaws — and apply audit methodologies (Slither, Mythril, manual review, formal verification basics).
			CO1	Apply SOC operations frameworks (NIST CSF, MITRE ATT&CK, Cyber Kill Chain) to map attacker tactics to defensive layers and design tier-1/2/3 SOC workflows.
			CO2	Apply log collection & aggregation pipelines (rsyslog, Filebeat, Fluentd, Vector) and SIEM platforms (Wazuh, Elastic Security, Splunk) to ingest, parse, and normalize security telemetry.
18	26CA6217E	Defensive Security	CO3	Analyze detection-engineering pipelines — Sigma rules, Splunk SPL, KQL (Kusto), Yara, OSQuery — to author high-fidelity, low-false-positive alerts mapped to MITRE ATT&CK techniques.
			CO4	Analyze network and endpoint telemetry — Zeek, Suricata, Sysmon, OSQuery, EDR — to perform threat hunting using pyramid-of-pain indicators.
			CO5	Evaluate incident response playbooks (SANS PICERL, NIST SP 800-61) and conduct hands-on digital forensics — disk, memory (Volatility 3), network


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				captures — to triage, contain, and learn from incidents.
			CO6	Evaluate threat-intelligence consumption (CTI feeds, MISP, OpenCTI, ATT&CK Navigator) and threat-modeling techniques (STRIDE, PASTA) to inform proactive defense priorities.
19	26CA6318E	Web3 & dApp Development	CO1	Apply Web3 frontend stack — ethers.js v6 / viem, wagmi hooks, RainbowKit / ConnectKit / Privy / WalletConnect — to build wallet-connected React dApps.
			CO2	Apply on-chain reads & writes — provider, signer, contract instances, transaction tracking, gas estimation, ENS resolution — with proper UX feedback.
			CO3	Analyze indexing patterns — The Graph subgraphs, GraphQL queries, alternatives (Goldskey, Alchemy Subgraphs, ponder.sh) — to design queryable on-chain data layers.
			CO4	Analyze decentralized storage (IPFS, Arweave, Filecoin) and metadata standards (ERC-721 metadata, OpenSea standards) for NFT & content dApps.
			CO5	Apply Layer-2 deployment patterns (Base, Arbitrum, Optimism, Polygon zkEVM) and cross-chain primitives (LayerZero, Wormhole, CCIP) for multi-chain dApps.
			CO6	Evaluate account abstraction (ERC-4337) and gasless / sponsored transactions to design dApps with mainstream UX.
20	26CA6319E	DevSecOps	CO1	Apply DevSecOps principles — shift-left, security-as-code, threat-modeling at design — to embed security gates throughout the SDLC.
			CO2	Analyze application-security tooling — SAST (Semgrep, Snyk Code, GitHub


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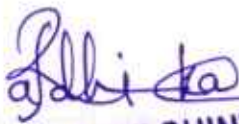
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				CodeQL), DAST (OWASP ZAP, Burp Pro), SCA (Snyk, Dependabot), secrets scanning (Gitleaks, TruffleHog) — and integrate them into CI/CD pipelines with proper severity gating.
			CO3	Analyze container & supply-chain security — image scanning (Trivy, Gype), SBOM generation (Syft, CycloneDX, SPDX), provenance attestations (SLSA, in-toto, Sigstore cosign).
			CO4	Apply Infrastructure-as-Code security — Terraform Cloud / OpenTofu policies (OPA / Rego, Sentinel), Checkov, tfsec, Terrascan — to prevent misconfigurations.
			CO5	Evaluate Kubernetes & runtime security — Pod Security Standards, network policies, OPA Gatekeeper / Kyverno, Falco runtime detection, eBPF-based observability (Cilium, Tetragon).
			CO6	Evaluate cloud security posture management (CSPM) — AWS Security Hub, GuardDuty, Inspector, Prowler, ScoutSuite — and design cloud-native defense-in-depth aligned with CIS Benchmarks & Well-Architected pillars.
21	26CA6320E	Data Science for Scale	CO1	Apply distributed data-processing fundamentals — partitioning, shuffling, MapReduce semantics, joins at scale, fault-tolerance — to reason about large-data workloads.
			CO2	Apply Apache Spark (DataFrame API + Spark SQL + PySpark) for batch ETL on multi-GB / multi-TB datasets, with proper partitioning, caching, and join strategies.
			CO3	Analyze streaming patterns — Kafka topics, partitions, consumer groups, exactly-once semantics, watermarks, windowing — to design real-time data


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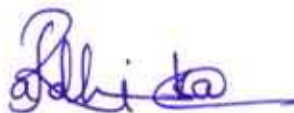
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				pipelines.
			CO4	Analyze stream-processing engines — Flink (event-time, stateful), Spark Structured Streaming, Kafka Streams — and choose the right tool per workload.
			CO5	Apply modern data-stack engineering — orchestration (Airflow, Dagster, Prefect), transformation (dbt), lakehouse formats (Delta, Iceberg, Hudi), data warehouse loading patterns.
			CO6	Evaluate data-quality, observability, lineage, and cost optimization — Great Expectations, Monte Carlo / DataHub / OpenLineage, query-cost analysis — for production-grade pipelines.
22	26CA61A1E	Conversational AI & Speech Systems	CO1	Apply automatic speech recognition pipelines (Whisper, Deepgram, Google STT) including streaming ASR, language identification, code-switching, and on-device alternatives (whisper.cpp, faster-whisper) for low-latency voice apps.
			CO2	Apply text-to-speech (TTS) systems — commercial (ElevenLabs, OpenAI TTS, Cartesia) and open-source (Coqui XTTS, Piper) — with voice-cloning, SSML markup, and real-time streaming for natural voice output.
			CO3	Analyze dialog architectures — intent-based (Rasa, Dialogflow), retrieval-based, and LLM-based (Claude, GPT-4o) — to design state machines, slot filling, multi-turn flows, and graceful fallbacks.
			CO4	Analyze voice-stack engineering — turn-taking, interruption handling, voice-activity detection (VAD), endpoint detection, latency budgets, jitter buffers — for telephony & real-time voice UX.
			CO5	Evaluate conversational quality — ASR


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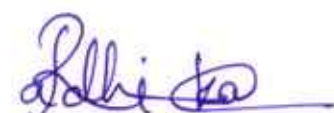
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				WER, TTS MOS, dialog success rate, completion rate, sentiment, escalation rate — using golden conversation sets, simulator-driven tests, and LLM-as-judge.
			CO6	Evaluate Indian-context challenges — multilingual + code-switched speech (Hindi-English, Telugu-English, Tamil-English), low-resource voice cloning, accents, and IndicNLP / AI4Bharat models.
23	26CA61B1E	Microservices, Service Mesh & Distributed Systems	CO1	Analyze microservices design patterns — service decomposition (DDD), API contracts, backwards compatibility, anti-corruption layers, strangler fig migrations — and apply them to real system designs.
			CO2	Apply service mesh technology (Istio, Linkerd, Cilium) — sidecar proxies, mTLS everywhere, traffic policy, retry budgets, circuit breakers, canary releases — on Kubernetes.
			CO3	Evaluate distributed-systems primitives — consensus (Raft, Paxos), leader election, distributed locks, vector clocks, gossip protocols — for correctness and performance trade-offs in real designs.
			CO4	Analyze distributed transaction patterns — 2PC, Saga (choreography vs orchestration), outbox pattern, compensating transactions, eventual consistency — for cross-service data integrity.
			CO5	Apply API design with gRPC + Protocol Buffers, GraphQL Federation (Apollo), and event-driven async with NATS/Kafka topics for inter-service communication.
			CO6	Evaluate failure-mode resilience — chaos engineering (Chaos Mesh, Litmus), fault injection, timeout cascades, retry storms, thundering


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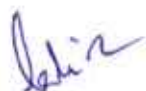

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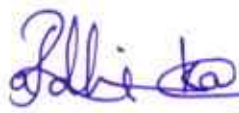
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				herd — using game-day exercises and post-mortems.
24	26CA61C1E	Advanced Threat Hunting & Adversary Emulation	CO1	Analyze the cyber kill chain (Lockheed Martin) and MITRE ATT&CK framework — tactics, techniques, sub-techniques, procedures — and map adversary behaviors to specific TTPs.
			CO2	Apply offensive-security tooling in authorized lab environments — Kali Linux, Caldera, Atomic Red Team, Sliver, Mythic, Metasploit — for adversary emulation exercises.
			CO3	Analyze threat-hunting hypotheses, KQL/SPL/Sigma queries, and SIEM log analysis (Splunk, Elastic, Microsoft Sentinel, Wazuh) for proactive detection.
			CO4	Apply detection engineering — writing Sigma rules, EQL queries, KQL analytics, mapping detections to ATT&CK techniques, false-positive triage.
			CO5	Analyze threat intelligence sources — STIX/TAXII feeds, IOCs, MISP, OpenCTI — and incorporate them into hunt + detection workflows.
			CO6	Evaluate purple-team exercises — coordinated red-blue collaboration, ATT&CK Navigator coverage maps, hunt reports, after-action reviews — for defensive maturity improvement.
25	26CA61D1E	DeFi Protocols & Tokenomics Engineering	CO1	Apply advanced Solidity 0.8.x patterns — assembly, transient storage (EIP-1153), custom errors, immutables, packed structs, gas optimization, ERC-2771 meta-tx, EIP-712 signatures — using Foundry / Hardhat with fuzz + invariant testing.
			CO2	Apply DeFi primitives — Uniswap V2/V3/V4 AMMs, Curve StableSwap, Compound III/Aave V3 lending, Velodrome ve(3,3), GMX perpetuals, Yearn vaults — via direct integration


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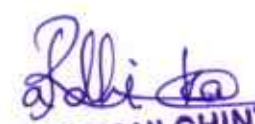
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				and forking.
			CO3	Analyze tokenomics — token supply schedules, vesting, emissions, ve-tokenomics, liquidity mining, protocol-owned liquidity, bonding curves, real-yield models — and design new protocol token-economic systems.
			CO4	Analyze oracle systems — Chainlink Data Feeds, Pyth, Tellor, UMA, oracle TWAP — and MEV (front-running, sandwich, JIT liquidity), with mitigation patterns (commit-reveal, batch auctions, MEV-Boost).
			CO5	Evaluate DeFi security — reentrancy, integer overflow, price manipulation, flash loan attacks, governance attacks, signature replay, upgradeable proxy pitfalls — using Slither, Mythril, Echidna, Foundry fuzzing, and formal verification with Certora.
			CO6	Evaluate multi-chain deployment — Ethereum L1, L2 rollups (Arbitrum, Optimism, Base, zkSync), Polygon PoS / zkEVM — and the Indian context (RBI digital asset advisories, 2022-23 crypto tax framework, FEMA implications, sandbox eligibility).
26	26CA61E1E	Analytics Engineering & Modern Data Platforms	CO1	Apply modern data platform architecture — cloud DW (Snowflake, BigQuery, Databricks, Redshift), data lakehouse (Iceberg, Delta, Hudi), ELT pipelines, separation of storage and compute — choosing the right tool for each workload.
			CO2	Apply ingestion patterns — Fivetran / Airbyte / Stitch (SaaS connectors), CDC with Debezium / dbt-source-freshness, batch vs streaming (Kafka / Kinesis / Confluent), Indian-source connectors (Razorpay, Zoho, Tally, GST APIs).
			CO3	Analyze dbt-based transformations — layered architecture (staging →


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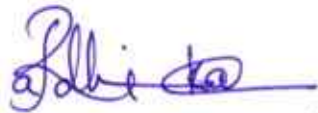
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				intermediate → marts), models, sources, seeds, snapshots, exposures, tests (generic + singular), macros, packages, dbt-utils, dbt_project_evaluator, CI / CD with dbt Cloud or GitHub Actions.
			CO4	Analyze semantic layers and metric stores — dbt MetricFlow, Cube, AtScale, Lightdash — for governed self-service BI; dimensional modelling (Kimball star schema), slowly-changing dimensions (SCD-2), one-big-table (OBT), data vault basics.
			CO5	Evaluate data quality & observability — Great Expectations, dbt tests, Soda Core, Monte Carlo / Lightup / Acceldata data observability platforms, freshness / volume / schema drift / distribution checks, data contracts (PACT-style).
			CO6	Evaluate orchestration (Airflow, Dagster, Prefect), governance (Unity Catalog, Atlan, Collibra, OpenMetadata, DataHub), Indian data-residency requirements (RBI Sep-2018 payments-data localisation, DPDP Act, IT Rules 2011 SPDI), cost optimization (warehouse sizing, query tuning, BI tool selection).
27	26IE3041E	TECHNICAL INTERNSHIP	CO1	Apply software engineering practices in an industry setting including version control, code review, branching strategies, ticketing systems, and onboarding processes used by the host organization.
			CO2	Apply technical contribution discipline (writing PRs, addressing review feedback, attending sprint ceremonies, communicating blockers) to ship measurable work product within the internship period.
			CO3	Examine the host organization's product, business model, technical architecture, customer base, and team


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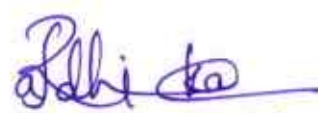
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				structure to contextualize own contribution within the broader system.
			CO4	Examine cross-functional collaboration patterns (developer-PM-design-QA-DevOps) and the cadence of professional engineering work (planning, daily standups, retrospectives, on-call).
			CO5	Apply professional communication and documentation standards in industry-grade artifacts including design docs, runbooks, README files, postmortems, and status updates.
			CO6	Architect a structured internship reflection that maps observations to learning outcomes and articulates intentional career direction informed by the experience.
28	26CA61A2E	Computer Vision & Multimodal AI	CO1	Apply CNN architectures (ResNet, EfficientNet, ConvNeXt) and Vision Transformers (ViT, Swin, DINOv2) for image classification, transfer learning, and fine-tuning.
			CO2	Apply object detection (YOLO v8/v9/v10/v11, RT-DETR, DETR) and segmentation (Mask R-CNN, SAM, SAM 2) for production CV pipelines.
			CO3	Analyze Vision-Language Models (VLMs) — CLIP, SigLIP, BLIP-2, LLaVA, Claude/GPT-4o vision — for image understanding, captioning, and visual question answering.
			CO4	Apply OCR & document AI (Tesseract, PaddleOCR, Donut, Marker, Mistral-OCR, Claude vision) for document understanding tasks.
			CO5	Analyze video understanding (action recognition, tracking, temporal segmentation) and multimodal fusion patterns for time-series visual data.
			CO6	evaluate CV deployment options — cloud APIs vs self-hosted, ONNX/TensorRT optimization, edge


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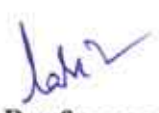

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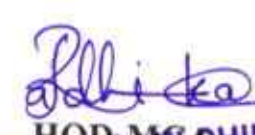
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				devices (Jetson, Coral), latency vs accuracy trade-offs — for real-time vision systems.
29	26CA61B2E	Event-Driven & Stream Processing Architectures	CO1	Apply Apache Kafka deeply — topics, partitions, replicas, consumer groups, offsets, idempotent producers, transactional producers, log compaction — for production-grade event streaming.
			CO2	Analyze stream-processing semantics — event time vs processing time, watermarks, windowing (tumbling, sliding, session), late arrivals, exactly-once vs at-least-once vs at-most-once.
			CO3	Apply stream-processing engines — Apache Flink (DataStream API), Spark Structured Streaming, Kafka Streams, ksqlDB — for real-time pipelines.
			CO4	Analyze event-driven architecture patterns — event sourcing, CQRS, event-driven microservices, choreography vs orchestration, schema evolution — for distributed systems.
			CO5	Apply real-time use cases — CDC pipelines, real-time fraud scoring, real-time analytics, IoT telemetry processing, real-time recommendation feature stores.
			CO6	Evaluate stream-pipeline observability, scaling, backpressure handling, dead-letter strategies, and end-to-end SLO management for production streaming workloads.
30	26CA61C2E	Privacy Engineering & Data Protection (DPDP, GDPR)	CO1	Analyze India's Digital Personal Data Protection (DPDP) Act 2023, EU GDPR, California CCPA/CPRA, and Singapore PDPA — compare obligations, definitions, lawful bases, and penalties.
			CO2	Apply consent management platforms and design consent UI flows (notice, granular consent, withdrawal)


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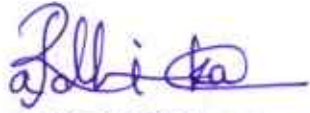
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				consistent with DPDP/GDPR requirements.
			CO3	Apply data subject rights (DSR) workflows — access, rectification, erasure, portability, objection — including identity verification and timeline tracking.
			CO4	Analyze Privacy-Enhancing Technologies (PETs) — k-anonymity, l-diversity, t-closeness, differential privacy, homomorphic encryption, secure multiparty computation, federated learning — for use cases.
			CO5	Apply privacy-by-design patterns — data minimization, purpose limitation, encryption schemes (envelope, AEAD, KMS-managed keys), tokenization, secure deletion, retention policies.
			CO6	Evaluate Data Protection Impact Assessments (DPIAs), Privacy Impact Assessments (PIAs), data-flow mapping, vendor risk, breach-notification workflows for regulatory readiness.
31	26CA61D2E	Fintech Apps — Payments, Trading, Lending	CO1	Apply UPI integration patterns — UPI 2.0, UPI Lite, UPI mandates, intent + collect flows, NPCI specs, PSP-bank-acquirer architecture — using sandbox APIs (Razorpay UPI, PhonePe PG, Cashfree).
			CO2	Apply card payments — PCI-DSS 4.0 scoping, tokenization (RBI tokenization mandate Sep-2022), 3-D Secure 2.0, ISO 8583 fundamentals, MDR economics, BBPS & e-NACH.
			CO3	Analyze trading systems — Order Management System (OMS), market-data ingestion via Zerodha Kite Connect / Upstox / ICICIdirect Breeze, FIX protocol primer, order types (limit, market, SL, OCO), risk-management gates, NSE/BSE microstructure.
			CO4	Analyze lending architecture — Loan


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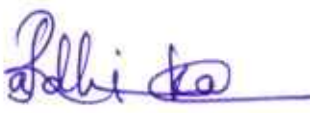
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32	26CA61E2E	Causal Analytics & Experimentation		Origination System (LOS), Loan Management System (LMS), credit decisioning, Account Aggregator framework, RBI Digital Lending Guidelines (Sep-2022), KYC tiers, TransUnion CIBIL / Experian / Equifax integration.
			CO5	Evaluate fintech security — PCI-DSS scope reduction, tokenization, vault patterns, fraud detection (rule + ML), velocity checks, device fingerprinting, AML/KYC, sanctions screening, RBI / FIU-IND reporting.
			CO6	Evaluate Indian fintech regulatory landscape — RBI PA/PG licensing, PSS Act 2007, NPCI bylaws, SEBI broker rules, RBI Digital Lending Guidelines, Account Aggregator (RBI 2016/2022), DPDP Act for fintech, SEBI cyber for capital markets, IRDAI for insurtech.
			CO1	Apply A/B test design — randomization unit (user/session/visit/cluster), MDE / power / sample-size calculation, sequential testing (mSPRT, AGT), Bayesian A/B (Beta-Binomial, Normal-Normal), peeking corrections, novelty / primacy effects, SUTVA assumption.
			CO2	Apply variance-reduction techniques — CUPED (Microsoft), CUPAC, stratification, post-stratification, regression adjustment, triggered analysis, ratio metrics with delta method, robust standard errors.
			CO3	Analyze quasi-experimental designs when randomization is impossible — difference-in-differences (DiD), synthetic control (Abadie), regression discontinuity (RDD), instrumental variables (IV), interrupted time series, propensity-score matching.
			CO4	Analyze observational causal inference using DoWhy + EconML — DAG-based identification (Pearl), backdoor / front-


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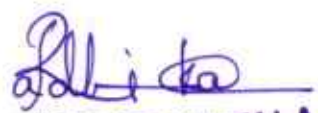
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				door criterion, double machine learning (DML), causal forests, T-learner / S-learner / X-learner / R-learner meta-learners.
			CO5	Evaluate switchback / interleaved / cluster-randomized experiments for two-sided marketplaces (Swiggy / Uber / Zomato), interference / SUTVA violations, network effects, geo-experiments (GeoLift, Meta's GeoLift), Bayesian structural time series (CausalImpact).
			CO6	Evaluate uplift modeling for personalization (Causal ML, Uber's PyLift, X-learner), multi-armed bandits (epsilon-greedy, Thompson sampling, LinUCB, contextual bandits), production experimentation platforms (Statsig, Eppo, Optimizely, GrowthBook, internal Swiggy / Flipkart platforms).
33	26CA62A3E	Recommender Systems & Personalization at Scale	CO1	Apply collaborative filtering (user-user, item-item, matrix factorization — ALS, SVD++, BPR), content-based, and hybrid recommender designs to baseline systems on industrial datasets.
			CO2	Analyze deep-learning recommender architectures — two-tower neural retrieval, NCF, DeepFM, DCN-V2, DIN, BST, SASRec, BERT4Rec — for retrieval and ranking layers.
			CO3	Analyze candidate-generation, ranking, re-ranking pipelines (the Pinterest / YouTube / Meta industrial pattern) and embedding-based retrieval at scale (FAISS, ScaNN, Vespa, Qdrant).
			CO4	Apply learning-to-rank techniques (pointwise, pairwise, listwise; LambdaMART, RankNet) and multi-objective ranking with business constraints.
			CO5	Evaluate offline metrics (NDCG, MAP,


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				Recall@K, MRR, Hit-Rate) and online metrics (CTR, watch-time, conversion, retention) including A/B-test design for recommender experiments.
			CO6	Evaluate cold-start strategies, exploration-exploitation (epsilon-greedy, Thompson sampling, contextual bandits), fairness, filter bubbles, and bias-aware design for production recommender systems.
34	26CA62B3E	SRE & Advanced Observability	CO1	Evaluate Service Level Indicators (SLI), Service Level Objectives (SLO), and error budgets to design reliability targets that balance feature velocity with stability.
			CO2	Apply OpenTelemetry instrumentation (logs, metrics, traces) at framework + library + auto-instrumentation levels for polyglot microservices.
			CO3	Analyze observability backends — Prometheus + Grafana, Loki, Tempo, Jaeger, OpenSearch, Honeycomb, Datadog, New Relic — for storage, query, alerting trade-offs.
			CO4	Apply continuous profiling (Pyroscope, Parca, Pixie/eBPF) and event-driven observability for advanced root-cause analysis.
			CO5	Analyze incident management — alert design, on-call runbooks, escalation policies, blameless post-mortems, MTTR/MTTD metrics, incident command pattern.
			CO6	Evaluate capacity planning, load shedding, graceful degradation, and chaos engineering for sustained reliability under growth and failure.
35	26CA62C3E	Cloud Native Security & Zero Trust Architecture	CO1	Apply zero-trust principles — identity-as-perimeter, continuous verification, least-privilege, micro-segmentation, lateral-movement prevention — based on NIST SP 800-207 and Google BeyondCorp.


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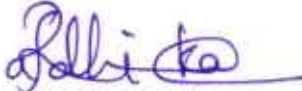
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			CO2	Analyze cloud IAM (AWS IAM + IAM Identity Center, Azure AD/Entra, GCP IAM) — policy structure, role assumption, federated identity, OIDC for workloads, IAM Access Analyzer for permission boundaries.
			CO3	Analyze workload identity — SPIFFE/SPIRE, Kubernetes ServiceAccounts, IRSA, GKE Workload Identity, Mtls in service mesh (Istio, Linkerd) — for service-to-service authentication.
			CO4	Analyze container & Kubernetes security — admission controllers (OPA Gatekeeper, Kyverno), Pod Security Standards, NetworkPolicies, image scanning (Trivy, Snyk), supply-chain (Cosign, SLSA), runtime security (Falco, Tetragon).
			CO5	Evaluate secrets management (HashiCorp Vault, AWS Secrets Manager, sealed-secrets), encryption-at-rest & in-transit, KMS architecture, key rotation, BYOK/HYOK for regulated industries.
			CO6	Evaluate cloud-security posture management (CSPM) — Wiz, Prowler, Checkov, Cloud Custodian, Sysdig — with Indian regulatory mapping (DPDP Act 2023, RBI cloud guidelines, MEITY Cyber Security Framework).
36	26CA62D3E	RegTech & Compliance Automation	CO1	Apply digital KYC pipelines — Aadhaar eKYC (UIDAI), DigiLocker, Video KYC (RBI Jan-2020 framework), CKYC, Re-KYC triggers, periodic KYC, beneficial ownership identification (UBO).
			CO2	Apply AML/CFT transaction monitoring — rule engines (Drools, Camunda DMN), velocity checks, structuring/layering detection, watchlist screening (OFAC, UN, RBI, SEBI debarred lists), STR/CTR generation in FIU-IND XML format.


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			CO3	Analyze regulatory reporting frameworks — RBI returns (XBRL filings, ADF, CIMS), SEBI BSE/NSE LODR filings, FIU-IND STR/CTR, GST returns (GSTR-1/3B/9), NPCI dispute reporting, Income Tax e-TDS / e-Invoicing.
			CO4	Analyze ML-driven AML/fraud detection — supervised models (XGBoost, LightGBM), unsupervised anomaly detection (Isolation Forest, Autoencoders), graph analytics (community detection on transaction graphs with Neo4j/NetworkX), explainable AI (SHAP, LIME) for regulator-grade explanations.
			CO5	Evaluate audit trail engineering — immutable logs (S3 object lock, AWS QLDB), evidence binders, regulator-replayable audit dashboards, board-grade compliance KPIs/KRIs aligned to RBI Cyber, SEBI Cyber, NPCI bylaws.
			CO6	Evaluate emerging RegTech themes — CBDC (e₹) compliance flows, RBI Account Aggregator data fiduciary obligations, DPDP Act 2023 fintech impact, SupTech initiatives (RBI's CIMS / DAKSH), GIFT IFSC sandbox compliance, ESG / climate reporting (BRSR).
37	26CA62E3E	Business Forecasting & Demand Analytics	CO1	Apply classical time-series forecasting — ETS / Holt-Winters / ARIMA / SARIMA / Prophet / TBATS — using statsforecast / sktime / Prophet / pmdarima with Box-Jenkins methodology, ACF/PACF analysis, residual diagnostics, KPSS / ADF stationarity tests.
			CO2	Apply machine-learning forecasting — LightGBM / XGBoost / CatBoost with lagged features + rolling stats + calendar features — using mlforecast, sklearn, and scikit-learn pipelines, with


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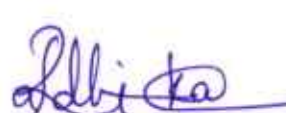
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				feature importance interpretation.
			CO3	Analyze deep-learning forecasters — N-BEATS, NHITS, Temporal Fusion Transformer (TFT), DeepAR (Amazon), DLinear/NLinear, PatchTST — using neuralforecast / GluonTS / PyTorch Forecasting / Darts; understand when DL beats classical (long horizons, many series, cross-learning).
			CO4	Analyze time-series foundation models — TimeGPT (Nixtla), Chronos (Amazon), Lag-Llama, Moirai (Salesforce), TimesFM (Google) — for zero-shot / few-shot forecasting; benchmark against classical and DL baselines on M4 / M5 datasets.
			CO5	Evaluate hierarchical reconciliation (top-down, bottom-up, MinT, OLS, WLS) for store/SKU/region hierarchies, intermittent demand (Croston, SBA, ADIDA, IMAPA, lumpy/sporadic patterns), probabilistic forecasting (quantile loss, MQRNN, conformal prediction), promotions/holiday modeling.
			CO6	Evaluate production deployment — backtesting (rolling-origin / expanding-window / blocked CV), MLOps for forecasting (MLflow / Weights & Biases / Comet), drift detection (data drift, concept drift), model monitoring, business alignment (sMAPE / RMSSE / WAPE / Pinball loss vs business KPIs), Indian-context demand drivers (monsoon / Diwali / Onam / IPL / wedding seasons / GST changes).
38	26CA63A4E	Intelligent Document Processing & RPA	CO1	Apply OCR & document-AI tools (Tesseract, PaddleOCR, AWS Textract, Azure Document Intelligence, Google Document AI, Donut, LayoutLMv3) for structured extraction from forms, invoices, contracts.
			CO2	Apply VLMs (Claude vision, GPT-4o

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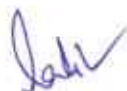
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				vision, Mistral-OCR) for direct document Q&A and entity extraction without intermediate OCR.
			CO3	Analyze classical RPA platforms (UiPath, Automation Anywhere, Power Automate) and AI-native browser/computer-use automation (Anthropic Computer Use, browser-use, BrowserBase) for workflow automation.
			CO4	Analyze workflow orchestration patterns — queues, retries, dead-letter handling, human-in-the-loop checkpoints, audit logging — using Temporal, Inngest, or Camunda.
			CO5	Apply Indian-context document AI — Aadhaar, PAN, GST invoices, bank statements, healthcare reports — using IndicOCR + AI4Bharat models.
			CO6	Evaluate IDP/RPA systems — field-level accuracy, end-to-end success rate, exception rate, cost per document, regulatory compliance — for production deployments.
39	26CA63B4E	Serverless, Edge & FaaS Computing	CO1	Apply Function-as-a-Service (FaaS) platforms — AWS Lambda, GCP Cloud Functions / Cloud Run, Azure Functions, Cloudflare Workers, Vercel Functions, Deno Deploy — for event-driven workloads.
			CO2	Analyze FaaS internals — cold-start mechanics, container/microVM (Firecracker), V8 Isolates (Cloudflare), provisioned concurrency, cold-start mitigation strategies.
			CO3	Analyze edge-computing primitives — CDN compute (Workers, Lambda@Edge, Fastly Compute@Edge), edge KV stores (Cloudflare KV, D1, R2), edge inference, edge-database replication.
			CO4	Apply serverless orchestration — AWS Step Functions, GCP Workflows,


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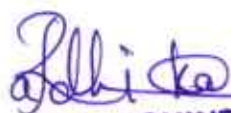
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				durable-functions patterns, fan-out/fan-in patterns, error-handling and retries. Evaluate serverless data — DynamoDB, FaunaDB, PlanetScale, Turso (libSQL), Cloudflare D1, Upstash Redis — for globally-replicated, serverless-friendly storage. Evaluate when to use serverless vs containers vs traditional compute — cost models, lock-in considerations, scale-to-zero benefits, observability gaps, performance trade-offs.
40	26CA63C4E	Security Governance, Risk & Compliance (GRC)	CO1	Apply security governance frameworks — ISO 27001:2022, NIST CSF 2.0, COBIT 2019, SOC 2 (Trust Services Criteria) — including policy authoring, control mapping, and ISMS scoping.
			CO2	Analyze risk management methodologies — ISO 31000, NIST SP 800-30/37/39, FAIR — and build quantitative + qualitative risk registers with realistic threat events.
			CO3	Analyze compliance regimes relevant to Indian industries — DPDP Act 2023, IT Rules 2011/2021, RBI Cyber Security Framework for banks/NBFCs, SEBI cybersecurity, IRDAI guidelines, MEITY framework, CERT-In directions.
			CO4	Analyze global compliance regimes — GDPR, HIPAA, PCI-DSS v4.0, SOX — and the gaps / overlaps with Indian regulations relevant to Indian IT-services exporters.
			CO5	Evaluate audit lifecycle — readiness assessment, gap analysis, remediation, evidence collection, internal audit, external audit, certification — using GRC platforms (Drata, Vanta, Sprinto, Trustero) and traditional spreadsheets.
			CO6	Evaluate incident response, business continuity (BCP) & disaster recovery


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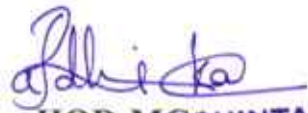
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				(DR), third-party risk management (TPRM), cyber insurance, board reporting, and KPI/KRI dashboards aligned to NIST CSF 2.0 outcomes.
41	26CA63D4E	Enterprise Distributed Ledger & Layer-2 Solutions	CO1	Apply Hyperledger Fabric 2.x — channels, ordering service (Raft), MSP, chaincode (Go / Node.js), endorsement policies, private data collections, identity mixer, gateway SDK — for permissioned enterprise networks.
			CO2	Apply alternative enterprise DLTs — R3 Corda (notary, flows, contracts in Kotlin), Quorum / Hyperledger Besu (private Ethereum), Hyperledger Indy / Aries (decentralized identity), DAML smart contracts — with deployment patterns.
			CO3	Analyze Ethereum Layer-2 architectures — optimistic rollups (Arbitrum Nitro, Optimism Bedrock, Base), ZK rollups (zkSync Era, StarkNet, Linea, Scroll, Polygon zkEVM), validiums, plasma, sidechains.
			CO4	Analyze modular blockchain architecture — Celestia data availability, EigenLayer restaking, AltLayer rollup-as-a-service, Polygon CDK, OP Stack, Arbitrum Orbit — for app-specific rollups.
			CO5	Evaluate cross-chain interoperability — LayerZero, Wormhole, Axelar, Chainlink CCIP, Hyperlane, IBC (Cosmos) — security trade-offs (lock-and-mint vs burn-and-mint vs liquidity pools), bridge security incidents (Ronin, Wormhole, Nomad), and mitigation patterns.
			CO6	Evaluate enterprise blockchain use-cases — trade finance (Marco Polo, we.trade), supply chain (IBM Food Trust, TradeLens), CBDC pilots (RBI e₹,


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				Project Dunbar), tokenized securities (HSBC Orion, JPMorgan Onyx), Indian enterprise blockchain (NPCI Vajra, IndiaChain).
42	26CA63E4E	Customer Growth & Behavioral Analytics	CO1	Apply cohort analysis and retention curves — classic, stratified by acquisition channel / geography / device / persona; D7 / D14 / D30 retention; rolling retention vs classic retention; Sean Ellis growth equation.
			CO2	Apply LTV (Lifetime Value) modeling — historical (cohort-based), predictive (BG/NBD + Gamma-Gamma via lifetimes library, BTYDplus), neural CLV, contractual vs non-contractual settings, payback period, LTV/CAC ratio.
			CO3	Analyze churn prediction — logistic regression / XGBoost / survival analysis (Cox PH, Kaplan-Meier), feature engineering for behavioral signals, class imbalance, calibration (Platt scaling, isotonic), threshold optimization, business action mapping.
			CO4	Analyze segmentation — RFM (Recency / Frequency / Monetary), K-means / Gaussian Mixture / hierarchical / DBSCAN, behavior-based segmentation with embeddings, latent-class models, persona development, ICP (Ideal Customer Profile) analytics.
			CO5	Evaluate marketing attribution (last-touch / first-touch / linear / time-decay / position-based / data-driven Markov / Shapley-value), Marketing Mix Modeling (MMM with PyMC + Robyn-style geo + saturation curves), incrementality testing (CausalImpact, GeoLift) in cookieless world.

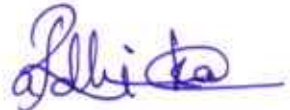

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			CO6 Evaluate product analytics — event taxonomy (Mixpanel / Amplitude / PostHog), funnel analysis, feature adoption, North Star metric design, AARRR pirate metrics, growth loops, viral coefficient (k-factor), Net Revenue Retention (NRR), Indian context (DPDP consent, server-side tracking).
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