

ALGOPROFESSOR CAMPUS · SKILL & EXPLORATION  
FRAMEWORKS



# Semester-wise Skill & Exploration Curriculum Framework

B.Tech in Computer Science & Engineering

An 8-semester, 8-exploration project model mapping each semester's core skill  
to industry, village, state, national and SDG problems

Curriculum suggestions & framework design

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## Preface & vision statement

### A note for heads of department

The industry does not hire syllabi: it hires **demonstrable capability**. This framework converts every semester of the B.Tech (CSE) programme into a paired unit of *skill acquisition* and *applied exploration*, so that by graduation each student carries not just a transcript but a portfolio of eight real, verifiable, deployed projects that speak directly to placement panels, startup incubators and global research programmes.

Every exploration project is anchored to a **real-world problem statement**, sourced from industry, neighbouring villages, state departments, India's national missions or the UN Sustainable Development Goals, so that students learn to build technology *for* people and places, not merely for assignments.

### Guiding principle: "Learn a skill. Solve a real problem. Prove it publicly."

Each semester has three fused components:

1. **Core skill track:** one dominant technical competency, taught to depth.
2. **Exploration project (E1–E8):** a mandatory, individually assigned project applying that semester's skill to a live problem statement.
3. **Public proof of work:** a mandatory e-Portfolio entry and GitHub repository submission under departmental governance.

## 1 Framework overview

**Framework name:** *EXPLORE: Eight-semester eXPerience Ladder for Original Research & Engineering*

**Applicability:** all B.Tech (CSE) students, all batches, mandatory

**Mandate:** every student completes **8 exploration projects**, one per semester, each mapped to that semester's core skill and to at least one external problem category (industry / village / state / national / SDG).

### 1.1 Semester → skill → exploration snapshot

| Sem | Core skill track                                             | Exploration project                       | Primary problem lens                                     |
|-----|--------------------------------------------------------------|-------------------------------------------|----------------------------------------------------------|
| I   | Programming Foundations (C & Python)                         | E1: Community Digitisation Utility        | Village record-keeping and small-business automation     |
| II  | Data Structures, Algorithms & OOP                            | E2: Efficient Systems for Public Services | Logistics, queueing and resource-allocation optimisation |
| III | Systems & Web: Operating Systems, Networks, Web Technologies | E3: Digital Public Service Portal         | Citizen service portals and grievance systems            |
| IV  | Software Engineering & Cloud-Native Development              | E4: Cloud-Native Service                  | Cloud services for markets, tourism and MSMEs            |
| V   | Full-Stack & Distributed Systems                             | E5: Scalable Full-Stack Platform          | Platforms for health, markets and skilling               |
| VI  | AI for Software Engineers: ML & Generative AI                | E6: AI-Enabled Application                | Multilingual and AI-assisted public services             |
| VII | DevOps, SRE & Agentic Systems                                | E7: Autonomous Operations System          | Automation, reliability and open-source contribution     |

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|             |                      |                               |                                                        |
|-------------|----------------------|-------------------------------|--------------------------------------------------------|
| <b>VIII</b> | Capstone Integration | E8: Combined Capstone Project | Deployable product: placement, startup or global track |
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## 2 Semester-wise skill & exploration details

### SEMESTER I | Programming Foundations (C & Python)

**Skill outcomes:** Syntax, data types, control flow, functions, pointers and memory basics, file handling, modular programs and simple command-line tools.

#### Exploration-1 (E1): Community Digitisation Utility

A C or Python command-line tool that replaces a manual, paper-based record for a real stakeholder.

- *Sample problem statements:* (VILLAGE) Gram panchayat birth and death register digitiser; (INDUSTRY) Kirana shop billing and stock command-line tool; (VILLAGE) School library issue-and-return tracker; (SDG) Rain-gauge and well-level logbook for a farmer group; (VILLAGE) Self-help group savings and loan ledger
- *Problem source(s):* Nearest village panchayat, local MSMEs, school offices
- *SDG mapping:* • SDG 1 No Poverty • SDG 9 Industry, Innovation & Infrastructure

### SEMESTER II | Data Structures, Algorithms & OOP

**Skill outcomes:** Arrays, linked lists, stacks, queues, trees, graphs, hashing, sorting and searching, greedy and dynamic programming, complexity analysis, object-oriented design.

#### Exploration-2 (E2): Efficient Systems for Public Services

An algorithm-driven solution that measurably improves an inefficient local or state process.

- *Sample problem statements:* (STATE) Shortest-route planner for state transport bus depots; (STATE) Priority-queue token system for a district hospital OPD; (NATIONAL) Fair-price-shop queue and slot allocation; (VILLAGE) Waste-collection route optimiser for a village; (INDUSTRY) Warehouse picking-path optimiser for an MSME
- *Problem source(s):* Gram Panchayat, State Transport Dept., district hospitals, local MSMEs
- *SDG mapping:* • SDG 11 Sustainable Cities • SDG 3 Good Health & Well-being

### SEMESTER III | Systems & Web: Operating Systems, Networks, Web Technologies

**Skill outcomes:** Processes, scheduling, memory, file systems, TCP/IP, HTTP, DNS, HTML/CSS/JavaScript, REST APIs and a first full web application.

#### Exploration-3 (E3): Digital Public Service Portal

A web application that makes a public or community service easier to reach, track or audit.

- *Sample problem statements:* (VILLAGE) Grievance-tracking portal for a gram panchayat; (NATIONAL) Scholarship-eligibility checker web app; (STATE) District blood-bank availability locator; (INDUSTRY) Product catalogue and enquiry site for a local MSME; (SDG) Accessible public-toilet and water-point finder
- *Problem source(s):* Panchayat offices, District Collector's office, state health portals, local MSMEs
- *SDG mapping:* • SDG 16 Peace, Justice & Strong Institutions • SDG 3 Good Health & Well-being

### SEMESTER IV | Software Engineering & Cloud-Native Development

**Skill outcomes:** SDLC and agile, design patterns, unit and integration testing, Docker, CI/CD pipelines, managed cloud services and API design.

## Exploration-4 (E4): Cloud-Native Service

A tested, containerised service deployed on the cloud with a CI/CD pipeline for a real user group.

- *Sample problem statements:* (VILLAGE) Farm-produce price board with SMS alerts for a mandi; (SDG) E-waste pickup booking microservice; (STATE) State tourism homestay booking API; (INDUSTRY) GST-ready invoicing microservice for MSMEs
- *Problem source(s):* Agricultural market committees, State Tourism Dept., industry partners
- *SDG mapping:* • SDG 8 Decent Work & Economic Growth • SDG 12 Responsible Consumption

### SEMESTER V | Full-Stack & Distributed Systems

**Skill outcomes:** Full-stack architecture, database scaling, caching, message queues, authentication, system-design fundamentals and performance testing.

## Exploration-5 (E5): Scalable Full-Stack Platform

A full-stack platform that stays fast and correct under realistic load for a governance or industry stakeholder.

- *Sample problem statements:* (STATE) District hospital bed-availability platform; (VILLAGE) Online store for a village self-help group; (NATIONAL) National skilling course-finder; (INDUSTRY) Shipment tracking platform for a local transporter
- *Problem source(s):* District health office, self-help groups, Skill India portals, industry partners
- *SDG mapping:* • SDG 8 Decent Work & Economic Growth • SDG 11 Sustainable Cities

### SEMESTER VI | AI for Software Engineers: ML & Generative AI

**Skill outcomes:** Machine-learning basics, LLM APIs, prompt design, retrieval-augmented generation, AI-assisted coding and evaluation of AI features.

## Exploration-6 (E6): AI-Enabled Application

An application where an ML model or LLM feature solves a real access, quality or productivity problem.

- *Sample problem statements:* (NATIONAL) Multilingual government-scheme assistant using RAG; (INDUSTRY) Code-review assistant for a startup's repositories; (VILLAGE) Crop-disease photo helper mobile app; (STATE) Student-query bot for a state examination board
- *Problem source(s):* Digital India themes, startup partners, State Agriculture and Education Depts.
- *SDG mapping:* • SDG 4 Quality Education • SDG 10 Reduced Inequalities

### SEMESTER VII | DevOps, SRE & Agentic Systems

**Skill outcomes:** Platform engineering, infrastructure as code, observability, incident response, multi-agent orchestration and security in delivery pipelines.

## Exploration-7 (E7): Autonomous Operations System

A self-operating system, multi-agent workflow or open-source contribution that runs reliably with little human effort.

- *Sample problem statements:* (INDUSTRY) Multi-agent IT helpdesk for an MSME; (STATE) Self-healing deployment for a public dashboard; (INDUSTRY) Contribution (PR/issue) to an open-source DevOps or agent framework; (VILLAGE) IoT and cloud smart street-light controller for a village; (SDG) Carbon-aware job scheduler for a data centre
- *Problem source(s):* Industry partners, startups, global open-source community, state smart-village missions
- *SDG mapping:* • SDG 9 Industry, Innovation & Infrastructure • SDG 17 Partnerships for the Goals

**SEMESTER VIII | Capstone Integration**

**Skill outcomes:** Full-stack system integration, product thinking, DevOps, UI/UX, documentation, pitching and IP awareness.

**Exploration-8 (E8): Combined Capstone Project**

Students combine their skills and, wherever feasible, earlier explorations (E1–E7) into one deployable product on a chosen track.

- *Tracks:* **Placement track** (Industry problem statement, mentored jointly by department faculty and a recruiting partner.); **Startup track** (Student-founded idea pitched to the institution's incubation cell, guided by industry mentors.); **Global Exposure track** (Co-supervised with international postdoctoral and Ph.D. research collaborators.)
- *Deliverables:* Deployed application, technical report, demo video, pitch deck, complete GitHub repository and e-Portfolio capstone entry.
- *Example capstone themes:* (INDUSTRY) Production SaaS module for an industry partner; (VILLAGE) Multilingual services marketplace for village artisans; (STATE) Citizen-services super-app combining earlier portals; (SDG) Cloud-native open-source project with international collaborators
- *Problem source(s):* Recruiting partners, incubation cell, international research collaborators
- *SDG mapping:* aligned to whichever SDGs the chosen capstone theme serves; declared at proposal stage.

## 3 Compulsory subjects, programming languages & tools, and global certification roadmap

### Basis of this mapping

Compiled by aligning (a) global-standard practice for computing programmes: core theory before applied specialisation, with a mandatory capstone; (b) ABET / NBA-style outcome-based subject sequencing; and (c) the skill sets most consistently sought by leading employers, so that learning outcomes and industry-recognised certifications reinforce each other every semester.

### 3.1 Semester-wise mapping table

| Sem        | Compulsory subjects                                                                                                                           | Programming languages & tools                                                                              | Recommended global certifications                                                                                                                      |
|------------|-----------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>I</b>   | Programming in C; Python Programming; Mathematics I; Digital Logic Design; Communication Skills                                               | C (GCC); Python 3; Git & GitHub; VS Code; Linux shell                                                      | PCEP – Certified Entry-Level Python Programmer (Python Institute); GitHub Foundations; NPTEL Programming in C (Elite)                                  |
| <b>II</b>  | Data Structures & Algorithms; Object-Oriented Programming (Java); Discrete Mathematics; Database Management Systems; Probability & Statistics | Java or C++; SQL; MySQL/PostgreSQL; GitHub Projects/Actions                                                | Oracle Certified Professional: Java SE 17 Developer; HackerRank Problem Solving (Data Structures) certificate; Oracle Database SQL Certified Associate |
| <b>III</b> | Operating Systems; Computer Networks; Web Technologies; Computer Organisation & Architecture; Theory of Computation                           | HTML/CSS/JavaScript; React; Node.js/Express; Linux/Bash; Wireshark                                         | Meta Front-End Developer Professional Certificate; Linux Foundation Certified IT Associate (LFCA); Cisco Networking Basics                             |
| <b>IV</b>  | Software Engineering; Design & Analysis of Algorithms; Cloud Computing; Software Testing; Compiler Design                                     | Spring Boot or Node.js; Docker; GitHub Actions; AWS/Azure; Postman; JUnit/Pytest                           | AWS Certified Cloud Practitioner; Microsoft Certified: Azure Fundamentals (AZ-900); ISTQB Certified Tester Foundation Level                            |
| <b>V</b>   | Full-Stack Development; Distributed Systems; Advanced Database Systems; Information Security; Professional Elective I                         | React/Next.js; Node.js or Spring Boot; PostgreSQL/MongoDB; Redis; Kafka basics; Kubernetes basics          | AWS Certified Solutions Architect – Associate; MongoDB Associate Developer; Certified Kubernetes Application Developer (CKAD)                          |
| <b>VI</b>  | Machine Learning; Generative AI Application Development; Software Architecture; Mobile Application Development; AI Ethics & Responsible AI    | Python; scikit-learn; LangChain/LlamaIndex; OpenAI/Anthropic APIs; FAISS/ChromaDB; Flutter or React Native | AWS Certified AI Practitioner; Generative AI with Large Language Models (DeepLearning.AI); Microsoft Certified: Azure AI Engineer Associate (AI-102)   |
| <b>VII</b> | DevOps & Site Reliability Engineering; Agentic AI Systems; Cyber Security Essentials; Research Methodology; Professional Elective III         | Kubernetes; Terraform; Prometheus/Grafana; LangGraph/CrewAI; GitHub Actions/Jenkins                        | Certified Kubernetes Administrator (CKA); HashiCorp Terraform Associate; GitHub Actions certification                                                  |

|             |                                                                                                                                 |                                                                                                                 |                                                                                         |
|-------------|---------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|
| <b>VIII</b> | Capstone Engineering Project; Product Management & Entrepreneurship; IP, Patents & Technical Communication; Industry Internship | Full-stack framework of choice; CI/CD; Docker/Kubernetes; cloud deployment (AWS/Azure/GCP); observability stack | Google Cloud Professional Cloud Architect; AWS Certified DevOps Engineer – Professional |
|-------------|---------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|

### 3.2 Cross-cutting skill ladders

These skills do not belong to a single semester. Employers expect them as continuous, compounding skills, so each is introduced, applied and brought to production grade across the eight semesters.

| Skill track               | Introduced                                  | Applied                                              | Production-grade                                                                   | Core tools & certifications                                                      |
|---------------------------|---------------------------------------------|------------------------------------------------------|------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|
| <b>Cloud &amp; DevOps</b> | Sem III (Linux, networking, virtualisation) | Sem IV–V (containers, CI/CD, managed cloud services) | Sem VII–VIII (Kubernetes, infrastructure as code, observability, capstone hosting) | AWS/Azure/GCP; Docker/Kubernetes; Terraform; AWS Cloud Practitioner, AZ-900, CKA |
| <b>System Design</b>      | Sem II (complexity, data modelling)         | Sem V (caching, queues, scaling a full-stack app)    | Sem VII–VIII (distributed design reviews, SLOs, capstone architecture)             | Redis, Kafka, PostgreSQL, load balancers, Prometheus/Grafana                     |
| <b>GenAI Engineering</b>  | Sem IV (AI-assisted coding, API basics)     | Sem VI (RAG applications and evaluation)             | Sem VII–VIII (agentic features in production products)                             | OpenAI/Anthropic APIs, LangChain/LlamaIndex, vector databases, LangGraph         |

## 4 Problem-statement sourcing matrix

### How the HoD curates individual problem statements each semester

For every semester, the HoD (with mentor faculty, industry liaisons and local administration contacts) compiles and *individually assigns* one problem statement per student from the five lenses below, so that no two students in the same batch receive an identical statement.

| Problem lens | Source channel                                                                | Coordinating body                                                            |
|--------------|-------------------------------------------------------------------------------|------------------------------------------------------------------------------|
| Industry     | Live or simulated challenges from industry partners and R&D collaborators     | Industry partners and MoUs, startup network, alumni network                  |
| Village      | Field visits, panchayat consultations, farmer and artisan interviews          | Gram Panchayat, NSS unit, faculty field coordinators                         |
| State        | Departmental open-problem calls and e-governance portals                      | State Agriculture, Rural Development, Water Resources and Health departments |
| National     | Alignment with Digital India, Smart Cities, Skill India and NEP 2020 missions | Ministries' open datasets and challenge portals, AICTE / NBA guidance        |
| SDG          | UN Sustainable Development Goals framework (17 goals)                         | Department SDG cell, mapped explicitly to each exploration                   |

**Duplication-avoidance rule:** every assigned problem statement is logged in the **Central Exploration Register** (section 5) with semester, academic year, roll number and status. Before any new statement is issued, the register is checked so that the same problem is never reassigned to a later batch unless the HoD explicitly marks it "open for extension", encouraging students to pick unsolved or extension-worthy problems from the growing repository.

## 5 e-Portfolio & GitHub governance

### 5.1 Departmental GitHub organisation

- **Organisation:** one department-owned GitHub organisation (suggested: YourInstitution-CSE-Explorations) with one repository per student per semester.
- **Repository naming convention:** SEM<n>\_<AcademicYear>\_<RollNo>\_<ShortProjectTitle>, e.g. SEM4\_2026-27\_21CS045\_MandiPriceAlerts
- **Mandatory repository contents:** problem statement, readme with objective, approach and results, source code, dataset or data-source citation, results and screenshots, short reflection on skill outcomes achieved.
- **Access:** mentor faculty and HoD as organisation owners and reviewers; the student as repository maintainer.

### 5.2 Student e-Portfolio

- An e-Portfolio page per student, updated at the end of every semester with that semester's exploration summary, skill badge and GitHub link.
- By the end of Semester VIII each student has a public, chronological, eight-project portfolio for placement interviews, startup pitches and international collaboration applications.

### 5.3 Central Exploration Register (sample structure)

| Sem | A.Y. | Roll No. | Project title | Problem lens | GitHub repo | Status |
|-----|------|----------|---------------|--------------|-------------|--------|
|-----|------|----------|---------------|--------------|-------------|--------|

|    |         |         |                        |                 |          |             |
|----|---------|---------|------------------------|-----------------|----------|-------------|
| IV | 2026-27 | 21CS045 | Mandi Price Alerts     | Village + SDG 8 | SEM4_... | Completed   |
| IV | 2026-27 | 21CS046 | E-Waste Pickup Service | SDG + SDG 8     | SEM4_... | In progress |

*Maintained live by the department office; illustrative rows only.*

## 6 Assessment & evaluation rubric (per exploration project)

| Criterion                                 | Weight | Descriptor                                                                                         |
|-------------------------------------------|--------|----------------------------------------------------------------------------------------------------|
| Problem understanding & real-world fit    | 15%    | Correct interpretation of the assigned industry, village, state, national or SDG problem statement |
| Skill application (semester's core skill) | 25%    | Depth and correctness of the semester's designated technical skill in the solution                 |
| Implementation & functionality            | 25%    | Working prototype or system, code quality, reproducibility                                         |
| Data / evidence basis                     | 10%    | Use of real or realistic data, field inputs, or validated assumptions                              |
| Documentation (README, report)            | 10%    | Clarity, completeness, reproducibility instructions                                                |
| GitHub & e-Portfolio compliance           | 10%    | Correct repository structure, timely submission, portfolio update                                  |
| Presentation / viva                       | 5%     | Communication of approach, results and learnings to a mentor or panel                              |

## 7 Governance roles

| Role                         | Responsibility                                                                                                                                        |
|------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| Head of Department           | Curates and individually assigns problem statements each semester; maintains the Central Exploration Register; approves Semester VIII capstone tracks |
| Mentor faculty (per section) | Weekly technical mentoring, mid-semester review, GitHub and portfolio compliance checks                                                               |
| Industry / startup liaison   | Supplies live industry problem statements; co-mentors Semester VII–VIII projects                                                                      |
| International co-supervisors | Research partners who co-mentor selected Semester VII–VIII students on the Global Exposure track                                                      |
| Student                      | Executes the exploration project, maintains the GitHub repository and e-Portfolio, presents at the semester-end review                                |

## 8 Implementation roadmap

### Suggested roll-out timeline

- Phase 1: Framework approval:** Present the framework to the Board of Studies / Academic Council for formal adoption into the B.Tech curriculum.
- Phase 2: Infrastructure set-up:** Create the departmental GitHub organisation, e-Portfolio hosting space and the Central Exploration Register.
- Phase 3: Problem bank seeding:** HoD, faculty and industry, village and state liaisons jointly seed the first problem statements across all five lenses for every semester.
- Phase 4: Pilot batch roll-out:** Launch with the current Semester I–II cohort and run E1–E2 as pilot explorations.
- Phase 5: Full-scale adoption:** Extend E1–E8 across all active batches; integrate exploration outcomes into OBE / CO–PO attainment and NBA / NAAC documentation.
- Phase 6: Annual review:** Review the register and rubric every academic year to retire saturated problem statements and induct new ones.

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