

ALGOPROFESSOR CAMPUS · SKILL & EXPLORATION
FRAMEWORKS



Semester-wise Skill & Exploration Curriculum Framework

B.Tech in Artificial Intelligence & Machine Learning

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 (AI & ML) 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 (AI & ML) 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 & Mathematics for AI	E1: Community Data Utility	Village and small-business data collection
II	Data Structures, Algorithms & Probability	E2: Efficient & Statistical Public Systems	Dispatch, allocation and anomaly detection
III	Foundations of AI & Classical Machine Learning	E3: AI for Social Good	Advisory and diagnostic systems for SDG themes
IV	Deep Learning & Computer Vision	E4: Vision Intelligence Engine	Agriculture, roads, safety and climate imagery
V	NLP & Data Engineering for ML	E5: Language & Data Pipeline	Indic-language and governance text data
VI	Large Language Models, Generative AI & Reinforcement Learning	E6: Conversational & Adaptive Intelligence	Multilingual assistants and RL-based optimisation
VII	Agentic AI, Physical AI & AI Safety	E7: Autonomous & Embodied Intelligence System	Agents, robotics and frontier-AI research

VIII 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 & Mathematics for AI

Skill outcomes: Python fluency, NumPy and plotting, linear algebra, calculus for optimisation, data collection and cleaning, simple scripts and notebooks.

Exploration-1 (E1): Community Data Utility

A Python tool that collects and summarises data for a real stakeholder who still uses paper or spreadsheets.

- *Sample problem statements:* (VILLAGE) Health-camp data logger with summary charts; (VILLAGE) Farmer input-cost tracker with season summaries; (INDUSTRY) Daily sales recorder with trend charts for an MSME; (NATIONAL) Mid-day meal attendance and nutrition logger
- *Problem source(s):* Primary Health Centres, farmer groups, local MSMEs, school administration
- *SDG mapping:* • SDG 1 No Poverty • SDG 2 Zero Hunger

SEMESTER II | Data Structures, Algorithms & Probability

Skill outcomes: Core data structures, graph and search algorithms, complexity, probability distributions, hypothesis testing and SQL for analytics.

Exploration-2 (E2): Efficient & Statistical Public Systems

An algorithmic or statistical solution that measurably improves a local or state service.

- *Sample problem statements:* (STATE) Nearest-ambulance dispatch for a district; (VILLAGE) Cold-storage slot allocation for farmers; (STATE) Exam-hall seating allocator for a state board; (NATIONAL) Statistical anomaly flags on ration-distribution records
- *Problem source(s):* District emergency services, farmer producer organisations, state examination boards
- *SDG mapping:* • SDG 2 Zero Hunger • SDG 3 Good Health & Well-being

SEMESTER III | Foundations of AI & Classical Machine Learning

Skill outcomes: Search and heuristics, knowledge representation, expert systems, regression, classification, clustering and model evaluation.

Exploration-3 (E3): AI for Social Good

A rule-based or classical-ML advisory system that supports a community decision.

- *Sample problem statements:* (VILLAGE) Crop-advisory expert system for local farmers; (VILLAGE) Symptom-triage assistant for a Primary Health Centre; (NATIONAL) Government-scheme eligibility advisor; (STATE) Student-dropout risk predictor for a district
- *Problem source(s):* State Agriculture Dept., PHC health workers, District Education Office
- *SDG mapping:* • SDG 2 Zero Hunger • SDG 3 Good Health & Well-being

SEMESTER IV | Deep Learning & Computer Vision

Skill outcomes: Neural networks, CNNs, transfer learning, object detection and segmentation, training at scale and deployment with ONNX/TFLite.

Exploration-4 (E4): Vision Intelligence Engine

A trained deep-learning model that detects, classifies or segments real images or video with measurable accuracy targets.

- *Sample problem statements:* (VILLAGE) Leaf-disease classifier for local farms; (STATE) Pothole detection from dashcam video for a city; (INDUSTRY) PPE-compliance detection on a factory floor; (SDG) Flood-extent mapping from satellite imagery
- *Problem source(s):* Agri-research stations, municipal corporations, industry partners, state disaster management authorities
- *SDG mapping:* • SDG 13 Climate Action • SDG 9 Industry, Innovation & Infrastructure

SEMESTER V | NLP & Data Engineering for ML

Skill outcomes: Text processing, embeddings, transformers for classification, Indic-language NLP, data pipelines, feature stores and cloud ML services.

Exploration-5 (E5): Language & Data Pipeline

A pipeline that turns raw text, speech or records into a deployed language or prediction model.

- *Sample problem statements:* (NATIONAL) Regional-language news classifier; (STATE) Grievance-text categoriser for a district administration; (INDUSTRY) Demand-forecast pipeline with a feature store for an MSME; (VILLAGE) Farmer voice-note transcription and tagging
- *Problem source(s):* Open government data portals, district administration, industry partners, farmer helplines
- *SDG mapping:* • SDG 10 Reduced Inequalities • SDG 16 Peace, Justice & Strong Institutions

SEMESTER VI | Large Language Models, Generative AI & Reinforcement Learning

Skill outcomes: Transformer internals, fine-tuning with LoRA/PEFT, retrieval-augmented generation, LLM evaluation, MDPs, Q-learning and policy gradients.

Exploration-6 (E6): Conversational & Adaptive Intelligence

An LLM or RL system that solves a multilingual-access, scheduling or optimisation problem at scale.

- *Sample problem statements:* (NATIONAL) Multilingual RAG assistant for government-scheme information; (STATE) RL-based traffic-signal timing simulation; (VILLAGE) Farmer-helpline LLM chatbot in a regional language; (INDUSTRY) LLM evaluation harness for a startup's product
- *Problem source(s):* Digital India themes, State Transport Dept., farmer helplines, startup partners
- *SDG mapping:* • SDG 10 Reduced Inequalities • SDG 7 Affordable & Clean Energy

SEMESTER VII | Agentic AI, Physical AI & AI Safety

Skill outcomes: Multi-agent orchestration, tool use and MCP, robotics with ROS 2, edge deployment on Jetson, and a guided seminar on AI safety and alignment.

Exploration-7 (E7): Autonomous & Embodied Intelligence System

A multi-agent or physically embodied AI system, or a supervised AI-safety research report.

- *Sample problem statements:* (INDUSTRY) Multi-agent workflow automating an industry back-office process; (VILLAGE) Drone-based crop-health survey for a farm cluster; (SDG) Robot-arm waste sorting for a recycling unit; (INDUSTRY) Contribution (PR/issue) to an open-source agent framework; (SDG) AI-safety literature review with a proposed evaluation framework
- *Problem source(s):* Industry partners, startups, global open-source community, state smart-village missions
- *SDG mapping:* • **SDG 9 Industry, Innovation & Infrastructure** • **SDG 12 Responsible Consumption**

SEMESTER VIII | Capstone Integration

Skill outcomes: End-to-end ML product delivery, MLOps, 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 deployed ML 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 ML system with monitoring for an industry partner; (VILLAGE) Edge-AI crop and livestock health kit; (NATIONAL) Indic-language voice assistant for public services; (SDG) Open LLM safety evaluation 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
I	Python Programming; Linear Algebra & Calculus; Digital Logic Design; Communication & Technical Writing	Python 3; NumPy; Matplotlib; Jupyter Notebook; Git & GitHub	PCEP – Certified Entry-Level Python Programmer (Python Institute); Google AI Essentials
II	Data Structures & Algorithms; Probability & Statistics; Object-Oriented Programming; Database Management Systems; Discrete Mathematics	Python or C++; SQL; pandas; GitHub Projects	HackerRank Problem Solving (Data Structures) certificate; Oracle Database SQL Certified Associate; Kaggle Learn: Python and pandas
III	Artificial Intelligence; Machine Learning I; Operating Systems; Optimisation for Machine Learning	scikit-learn; NumPy/SciPy; Prolog basics; Linux/Bash	Microsoft Certified: Azure AI Fundamentals (AI-900); AWS Certified AI Practitioner
IV	Deep Learning; Computer Vision; Software Engineering; MLOps Basics	PyTorch; Keras; OpenCV; Ultralytics YOLO; FastAPI; ONNX/TFLite	NVIDIA DLI: Fundamentals of Deep Learning; DeepLearning.AI Deep Learning Specialisation
V	Natural Language Processing; Big Data for Machine Learning; Cloud Computing; Statistical Inference	Hugging Face Transformers; spaCy; Apache Spark; Airflow; SageMaker or Azure ML	AWS Certified Machine Learning Engineer – Associate; Databricks Certified Machine Learning Associate
VI	Reinforcement Learning; Large Language Models & Generative AI; Vector Databases & RAG; AI Ethics & Responsible AI	Hugging Face; PEFT/LoRA; LangChain/LlamaIndex; Gymnasium/RLlib; FAISS/ChromaDB/Weaviate	Generative AI with Large Language Models (DeepLearning.AI); NVIDIA DLI: Building RAG Agents with LLMs; Microsoft Certified: Azure AI Engineer Associate (AI-102)
VII	Agentic AI Systems; Robotics & Physical AI; Edge AI & IoT; AI Safety & Alignment Seminar	LangGraph/AutoGen/CrewAI; MCP; ROS 2; NVIDIA Jetson; Isaac Sim/Gazebo	NVIDIA Jetson AI Specialist; IAPP Artificial Intelligence Governance Professional (AIGP)
VIII	Capstone Engineering Project; MLOps & Cloud Deployment; AI Product Management & Entrepreneurship; IP, Patents & Technical Communication	MLflow/Kubeflow; CI/CD; FastAPI + React; vector database + LLM integration; cloud deployment (AWS/Azure/GCP)	Google Cloud Professional Machine Learning Engineer; AWS Certified Machine Learning Engineer – Associate

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
MLOps	Sem IV (model packaging, FastAPI, ONNX)	Sem V (pipelines, experiment tracking, cloud ML)	Sem VII–VIII (monitoring, drift, CI/CD for models)	MLflow, Docker, Kubernetes, SageMaker/Azure ML; AWS ML Engineer – Associate
LLM & RAG Engineering	Sem V (embeddings, tokenisers)	Sem VI (fine-tuning, RAG, evaluation)	Sem VII–VIII (agents, tool use, production RAG)	Hugging Face, PEFT/LoRA, FAISS/ChromaDB/Weaviate, LangGraph, MCP
Edge & Physical AI	Sem IV (quantisation, ONNX/TFLite)	Sem VII (ROS 2, Jetson, sensor fusion)	Sem VIII (deployed embodied or edge product)	NVIDIA Jetson, ROS 2, Isaac Sim/Gazebo; Jetson AI Specialist

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-AIML-Explorations) with one repository per student per semester.
- **Repository naming convention:** SEM<n>_<AcademicYear>_<RollNo>_<ShortProjectTitle>, e.g. SEM4_2026-27_21AM045_LeafDiseaseClassifier
- **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
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IV	2026-27	21AM045	Leaf Disease Classifier	Village + SDG 13	SEM4_...	Completed
IV	2026-27	21AM046	Pothole Detector	State + SDG 13	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.

Curriculum suggestions & framework design

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