GENERATIVE & AGENTIC AI SYLLABUS

Module	Hours	Sessions	Topics	Learning Outcomes	Session Breakdown
Intro & Orientation	3	1	Introduction to AI Landscape- Course Overview & Tools Setup- Expectations, Ethics & Responsible AI	Understand course objectives- Identify AI categories and trends- Set up environment and guidelines	• Session 1: Course overview, expectations, setup, AI ecosystem introduction
ML Fundamentals	3	1	Supervised vs Unsupervised Learning- Regression & Classification Basics- Evaluation Metrics Overview	Grasp key ML concepts- Differentiate between ML paradigms- Apply evaluation metrics appropriately	• Session 1: Core ML types, regression/classification demos, metrics practice
Deep Learning & Transformers	12	4	Neural Networks Fundamentals- CNNs, RNNs, LSTMs Overview- Transformer Architecture & Self-Attention- BERT, GPT & Vision Transformers	Explain the architecture of neural networks- Understand sequence and vision models- Comprehend transformer mechanisms	• Session 1: Neural Network basics & architecture • Session 2: CNNs & RNNs practical demo • Session 3: Transformers explained (Self-Attention, Positional Encoding) • Session 4: Hands-on with BERT/GPT demo
Generative AI Fundamentals	24	8	Generative AI Concepts & Types- Diffusion Models- Fine-tuning (LoRA, PEFT)- Prompt-based Generation- Ethics in Generative Models	Understand various generative architectures- Apply fine-tuning and adaptation techniques- Discuss ethical implications of AI-generated content	• Session 1: Intro to Generative AI • Session 2: Variational Autoencoders & GANs • Session 3: Diffusion Models deep dive • Session 4: LoRA & PEFT fine-tuning • Session 5: Text generation hands-on • Session 6: Image generation with Diffusion

					• Session 7: Evaluation of Generative Models • Session 8: Ethics of GenAI -Practical implementation lab
Advanced Prompting & Reasoning	12	4	Prompt Engineering Evolution- Chain of Thought & Multi-Step Reasoning- Tool Use & Function Calling- Context Management & Optimization	Develop advanced prompting workflows- Implement reasoning chains- Use tools effectively with LLMs	• Session 1: Advanced prompting theory • Session 2: Chain-of-Thought reasoning practice • Session 3: Function calling & API integration • Session 4: Context management and optimization lab
Agentic AI Fundamentals	18	6	Autonomous Agents & Architecture- Tool Use & Planning- Memory Systems- Safety & Ethics in Agents	Build and deploy autonomous agents- Integrate tools and planning modules- Implement safe and ethical control mechanisms	• Session 1: Agentic AI concepts & architecture • Session 2: Agent • workflow with tools • Session 3: Planning and decision trees • Session 4: Memory & context retention • Session 5: Ethics & safety in autonomous agents • Session 6: Practical agent implementation
Multi-Agent Systems	18	6	Communication Between Agents- Coordination & Cooperation- Emergent Behaviors- Multi-Agent Simulation Projects	Understand multi-agent dynamics- Develop cooperative and competitive systems- Simulate real-world multi-agent workflows	• Session 1: Multi-agent fundamentals • Session 2: Coordination & messaging protocols • Session 3: Cooperative vs competitive agents • Session 4: Multi-agent environments simulation • Session 5: Large-scale orchestration • Session 6: Capstone-style project build

RAG & Memory Systems	9	3	RAG Fundamentals- Advanced RAG Techniques (Fusion, Re-ranking)- Memory Augmented Models	Implement retrieval-augmented generation- Enhance retrieval quality- Use memory for long-term context	• Session 1: Intro to RAG concepts • Session 2: Advanced RAG & Fusion methods • Session 3: Practical RAG and memory lab
Agent Deployment & Monitoring	9	3	API Integration- Monitoring & Logging- Cost Optimization & Scaling	Deploy agents efficiently- Track performance & manage costs- Optimize for scalability	• Session 1: Deployment architecture • Session 2: Monitoring & logging systems • Session 3: Cost optimization & scaling strategies
Industry Trends & AI Governance	6	2	Recap of All Modules - Industry Trends & AI Governance	Summarize learning outcomes - Discuss future trends and governance challenges	• Session 1: Comprehensive recap of all previous modules • Session 2: AI industry trends & governance discussion
Capstone Project	6	2	Project Planning, Implementation, Evaluation & Presentation	Apply all learned concepts to develop a real AI solution	• Session 1: Implementation phase 1 • Session 2: Implementation phase 2 & Final presentation & feedback
Total	**120**	**40**			

Generative & Agentic AI – Comprehensive Professional Program

Module Title	Session Title	Hours	No. of Sessions
Intro & Orientation	Course Overview, Setup & Responsible AI	3	1

Session Topics Breakdown

Session	Detailed Topics
Session 1	- Introduction to AI Landscape - Course Overview & Tools Setup - Expectations, Ethics & Responsible AI

Detailed Session Plan

Time	Section	Detailed Content / Activities	Learning Outcome
0:00 – 0:20	Welcome & Icebreaker	- Trainer introduction & participant expectations - Discuss course goals and outcomes	Understand course objectives and learning roadmap
0:20 – 0:50	AI Landscape Overview	- Definition & categories (Narrow, General, Generative, Agentic) - Historical timeline & key breakthroughs	Identify AI categories and current industry trends
0:50 – 1:30	Tools Setup	- Installation & configuration (Python, Jupyter, VS Code) - Git/GitHub quick setup - Overview of libraries used in later modules	Set up development environment successfully
1:30 – 1:45	Break (15 min)		
1:45 – 2:30	Responsible & Ethical AI	- Bias, transparency, accountability - Case studies: misuse of generative AI - Discussion: “Can AI be truly ethical?”	Recognize the importance of responsible AI practices
2:30 – 3:00	Recap & Q&A	- Summary of key takeaways - Open discussion on AI in students’ domains	Reflect on learning & connect with personal context

Module Title	Session Title	Hours	No. of Sessions
Machine Learning Fundamentals	Supervised vs Unsupervised Learning, Regression & Classification Basics, Evaluation Metrics	3	1

Session Topics Breakdown

Session	Detailed Topics
Session 1	- Introduction to Machine Learning Concepts- Supervised vs Unsupervised Learning- Regression & Classification Basics- Evaluation Metrics Overview

Detailed Session Plan

Time	Section	Detailed Content / Activities	Learning Outcome
0:00 – 0:20	**Introduction to ML Concepts**	- Overview of Machine Learning- Traditional Programming vs ML- Real-world ML applications (recommendation systems, fraud detection)	Understand the basic idea and use cases of ML
0:20 – 0:50	**ML Paradigms**	- Supervised vs Unsupervised Learning- Key differences and examples- Short visual demo: classification vs clustering	Differentiate between ML paradigms
0:50 – 1:30	**Regression Fundamentals**	- Linear Regression introduction- Simple demo in Python- Relationship between input/output variables	Understand regression and its applications

1:30 – 1:45	**Break (15 min)**		
1:45 – 2:20	**Classification Fundamentals**	- Binary vs Multi-class classification- Use cases: spam detection, sentiment analysis- Demo using Scikit-learn	Understand classification tasks and their implementation
2:20 – 2:50	**Evaluation Metrics Overview**	- Accuracy, Precision, Recall, F1-score- Confusion Matrix- Regression metrics (MAE, MSE, R^2)	Apply metrics to evaluate model performance
2:50 – 3:00	**Recap & Q&A**	- Recap of main concepts- Quick quiz or discussion	Reinforce learning and clear doubts

Generative & Agentic AI – Comprehensive Professional Program

Module Title	Session Title	Hours	No. of Sessions
Deep Learning & Transformers	Neural Networks, CNNs/RNNs, Transformers, and Hands-on with BERT/GPT	12	4

Session Topics Breakdown

Session	Detailed Topics
Session 1	- Neural Networks Fundamentals- Activation Functions- Forward & Backpropagation
Session 2	- CNNs: Convolution, Pooling, Feature Maps- RNNs & LSTMs Overview- Practical Demo on Image/Text Data
Session 3	- Transformer Architecture- Self-Attention & Positional Encoding- Comparing RNNs vs Transformers
Session 4	- Hands-on with BERT & GPT- Vision Transformers (ViT)- Real-world Transformer Applications

Detailed Session Plan

Session 1: Neural Network Basics & Architecture

Time	Section	Detailed Content / Activities	Learning Outcome
0:00 – 0:20	**Introduction to Deep Learning**	- Evolution from ML to DL- Key applications and importance	Understand why deep learning matters
0:20 – 0:50	**Neural Network Fundamentals**	- Perceptron model, weights, bias- Activation functions (ReLU, Sigmoid, Tanh)	Learn how neurons and activations build learning models
0:50 – 1:30	**Forward & Backpropagation**	- Training process explained step-by-step- Gradient descent & loss functions visualization	Understand NN training workflow
1:30 – 1:45	**Break (15 min)**		
1:45 – 2:30	**Hands-on Coding (Basic NN)**	- Build a simple neural network using PyTorch or TensorFlow	Implement a simple NN model
2:30 – 3:00	**Recap & Discussion**	- Q&A + best practices in NN design	Summarize learning concepts

Session 2: CNNs & RNNs Practical Demo

Time	Section	Detailed Content / Activities	Learning Outcome
0:00 – 0:20	**CNN Concepts**	- Convolution, pooling, feature extraction	Understand CNN working principles
0:20 – 0:50	**CNN Architecture Deep Dive**	- Layers, filters, stride, padding explained	Visualize image feature learning
0:50 – 1:30	**CNN Practical Lab**	- Build CNN using Keras or PyTorch- Train on MNIST or CIFAR dataset	Apply CNN for image classification
1:30 – 1:45	**Break (15 min)**		
1:45 – 2:20	**RNN & LSTM Overview**	- Sequential data, vanishing gradient problem- LSTM/GRU solutions	Understand sequence modeling
2:20 – 3:00	**RNN Coding Demo**	- Implement text sequence prediction with RNN/LSTM	Build and evaluate sequential models

Session 3: Transformers Explained (Self-Attention, Positional Encoding)

Time	Section	Detailed Content / Activities	Learning Outcome
0:00 – 0:30	**RNN Limitations & Transition to Transformers**	- Why Transformers outperform RNNs- Parallelization benefits	Identify transformer advantages
0:30 – 1:00	**Self-Attention Mechanism**	- Query, Key, Value concept- Attention visualization	Understand the inner mechanism of attention
1:00 – 1:30	**Positional Encoding**	- Handling sequence order- Demo: encoding visualization	Grasp positional embedding purpose
1:30 – 1:45	**Break (15 min)**		
1:45 – 2:30	**Transformer Architecture Walkthrough**	- Encoder-decoder, multi-head attention, layer normalization	Explain transformer components
2:30 – 3:00	**Hands-on Mini Demo**	- Run a small transformer model on text data	Apply transformer knowledge in practice

Session 4: Hands-on with BERT/GPT & Vision Transformers

Time	Section	Detailed Content / Activities	Learning Outcome
0:00 – 0:20	**Introduction to Pretrained Models**	- Concept of pretraining & fine-tuning	Understand pretrained transformer models
0:20 – 0:50	**BERT Overview**	- Masked language modeling- Demo: sentence embedding	Learn BERT's bi-directional architecture
0:50 – 1:30	**GPT Overview**	- Generative transformer model- Text generation hands-on	Apply GPT for text generation
1:30 – 1:45	**Break (15 min)**		
1:45 – 2:20	**Vision Transformers (ViT)**	- Image patches, embedding, and transformer pipeline	Understand ViT mechanism
2:20 – 3:00	**Final Recap & Integration Discussion**	- Compare CNN, RNN, Transformer applications- Best practices and next steps	Synthesize learning across DL models

Module Title	Session Title	Hours	No. of Sessions
Generative AI Fundamentals	Generative AI Concepts, Diffusion Models, Fine-tuning, Prompt-based Generation & Ethics	24	8

Session Topics Breakdown

Session	Detailed Topics
Session 1	**Introduction to Generative AI: Concepts, History, Applications**
Session 2	**Variational Autoencoders (VAEs) & Generative Adversarial Networks (GANs)**
Session 3	**Diffusion Models: Principles, Architectures, Applications**
Session 4	**Fine-tuning Techniques: LoRA, PEFT**
Session 5	**Text Generation Hands-on: LLMs, Prompt Engineering**
Session 6	**Image Generation Hands-on: Diffusion Models, Stable Diffusion**
Session 7	**Evaluation of Generative Models: Metrics, Benchmarking, Limitations**
Session 8	**Ethics of Generative AI & Practical Implementation Lab**

Detailed Session Plan

Session 1 – Intro to Generative AI

Time	Section	Detailed Content / Activities	Learning Outcome
0:00 – 0:20	Welcome & Icebreaker	Trainer intro, participant expectations, course roadmap	Understand course objectives & roadmap
0:20 – 1:00	Generative AI Overview	Definition, history, key breakthroughs, real-world applications	Identify generative AI use-cases & architectures
1:00 – 1:45	Types of Generative Models	VAEs, GANs, Diffusion Models overview	Differentiate between generative architectures
1:45 – 2:00	Break	15 min	—
2:00 – 2:45	Hands-on Demo	Simple example with pre-trained text/image model	See generative AI in action
2:45 – 3:00	Recap & Q&A	Summarize key takeaways	Reflect & connect to practical applications

Session 2 – VAEs & GANs

Time	Section	Detailed Content / Activities	Learning Outcome
0:00 – 0:30	VAE Theory	Latent space, encoder-decoder, reconstruction loss	Understand VAE architecture & use-cases
0:30 – 1:30	GAN Theory	Generator & Discriminator, adversarial loss, training challenges	Comprehend GAN mechanics & applications
1:30 – 1:45	Break	15 min	—
1:45 – 2:45	Practical Demo	Implement small VAE & GAN models in PyTorch	Apply generative model coding skills

2:45 – 3:00	Recap & Q&A	Discuss results & challenges	Reflect on implementation & evaluation

Session 3 – Diffusion Models Deep Dive

Time	Section	Detailed Content / Activities	Learning Outcome
0:00 – 0:30	Introduction to Diffusion	Noise-to-data generation, Markov chains	Explain diffusion model principles
0:30 – 1:15	Model Architectures	Denoising diffusion, score-based models	Understand architecture variations
1:15 – 1:30	Break	15 min	—
1:30 – 2:30	Hands-on Demo	Generate images from pre-trained diffusion model	Apply diffusion models practically
2:30 – 3:00	Discussion	Compare VAEs, GANs, Diffusion models	Evaluate pros & cons of each

Session 4 – LoRA & PEFT Fine-tuning

Time	Section	Detailed Content / Activities	Learning Outcome
0:00 – 0:30	Fine-tuning Overview	Transfer learning, low-rank adaptation, PEFT concepts	Understand fine-tuning strategies
0:30 – 1:30	LoRA Demo	Apply LoRA on small language model	Implement LoRA fine-tuning
1:30 – 1:45	Break	15 min	—
1:45 – 2:45	PEFT Demo	Apply PEFT method, compare with LoRA	Adapt and optimize model performance
2:45 – 3:00	Recap & Q&A	Discuss scenarios & limitations	Reflect on fine-tuning applications

Session 5 – Text Generation Hands-on

Time	Section	Detailed Content / Activities	Learning Outcome
0:00 – 0:30	Prompt Engineering	Techniques, templates, advanced prompting	Build effective prompts
0:30 – 1:30	Text Generation	Generate text using GPT, evaluate quality	Apply prompt-based text generation
1:30 – 1:45	Break	15 min	—
1:45 – 2:45	Hands-on Lab	Fine-tune prompt strategies, experiment outputs	Practice iterative prompt refinement
2:45 – 3:00	Recap & Q&A	Discuss model behavior	Reflect on limitations & ethics

Session 6 – Image Generation Hands-on

Time	Section	Detailed Content / Activities	Learning Outcome
0:00 – 0:30	Image Generation Overview	Text-to-Image pipelines, Stable Diffusion intro	Understand image generative models
0:30 – 1:30	Hands-on Lab	Generate images, modify prompts, control style	Apply image generation practically
1:30 – 1:45	Break	15 min	—
1:45 – 2:45	Experimentation	Fine-tune prompts, adjust parameters	Evaluate image quality & variations
2:45 – 3:00	Recap & Q&A	Discuss practical challenges	Reflect on generative image techniques

Session 7 – Evaluation of Generative Models

Time	Section	Detailed Content / Activities	Learning Outcome
0:00 – 0:45	Evaluation Metrics	FID, IS, BLEU, perplexity	Apply proper evaluation metrics

0:45 – 1:30	Benchmarking	Compare model outputs, datasets	Critically assess model performance
1:30 – 1:45	Break	15 min	—
1:45 – 2:45	Hands-on	Evaluate text & image models on sample tasks	Implement evaluation workflow
2:45 – 3:00	Discussion	Limitations, best practices	Reflect on generative AI evaluation

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Session 8 – Ethics & Practical Implementation Lab

Time	Section	Detailed Content / Activities	Learning Outcome
0:00 – 0:30	Ethics Overview	Bias, hallucination, misinformation, misuse	Recognize ethical concerns in GenAI
0:30 – 1:30	Case Studies	Real-world examples of misuse & mitigation	Discuss responsible AI practices
1:30 – 1:45	Break	15 min	—
1:45 – 2:45	Practical Lab	Build mini project using text/image generation	Apply all learned generative concepts
2:45 – 3:00	Final Recap & Presentation	Share results, peer feedback	Reflect on learning & ethical implications

Module Title	Session Title	Hours	No. of Sessions
Advanced Prompting & Reasoning	Prompt Engineering, Reasoning Chains, Tool Use & Context Management	12	4

Session Topics Breakdown

Session Detailed Topics

Session 1 Advanced Prompting Theory: Evolution, Principles, Best Practices

Session 2 Chain-of-Thought & Multi-Step Reasoning: Techniques & Practice

Session Detailed Topics

Session 3 Function Calling & API Integration with LLMs

Session 4 Context Management & Optimization Lab

Detailed Session Plan

Session 1 – Advanced Prompting Theory

Time	Section	Detailed Content / Activities	Learning Outcome
0:00 – 0:20	Welcome & Recap	Brief review of previous generative AI concepts	Connect prior knowledge to prompting
0:20 – 1:00	Prompt Engineering Evolution	From basic to advanced prompts, templates, prompt chaining	Understand evolution of prompting techniques
1:00 – 1:45	Best Practices & Pitfalls	Examples of good vs bad prompts, strategies to reduce hallucinations	Apply advanced prompting principles
1:45 – 2:00	Break	15 min	—
2:00 – 2:45	Demo & Discussion	Show LLM responses with different prompts, analyze outputs	Evaluate prompts critically
2:45 – 3:00	Q&A	Open discussion	Reflect on learning outcomes

Session 2 – Chain-of-Thought Reasoning Practice

Time	Section	Detailed Content / Activities	Learning Outcome
0:00 – 0:30	Introduction to CoT	Principles of Chain-of-Thought, multi-step reasoning	Understand reasoning chains in LLMs
0:30 – 1:30	Examples & Patterns	Solve example problems using CoT prompts	Implement reasoning chains
1:30 – 1:45	Break	15 min	—

1:45 – 2:45	Hands-on Lab	Students design CoT prompts for sample tasks	Practice structured reasoning workflows
2:45 – 3:00	Recap	Discussion of challenges & insights	Reflect on reasoning effectiveness

Session 3 – Function Calling & API Integration

Time	Section	Detailed Content / Activities	Learning Outcome
0:00 – 0:30	Overview	Function calling concept in LLMs, API basics	Understand integration capabilities
0:30 – 1:30	Tool Use	How LLMs call external functions, use plugins or tools	Use tools effectively with LLMs
1:30 – 1:45	Break	15 min	—
1:45 – 2:45	Hands-on Lab	Implement a small workflow calling functions via API	Apply function calling in practice
2:45 – 3:00	Q&A & Discussion	Review results, discuss challenges	Reflect on integration techniques

Session 4 – Context Management & Optimization Lab

Time	Section	Detailed Content / Activities	Learning Outcome
0:00 – 0:30	Context Principles	Long-term memory, conversation context, prompt optimization	Understand context management strategies
0:30 – 1:30	Techniques	Sliding window, summarization, memory augmentation	Implement context-aware prompts
1:30 – 1:45	Break	15 min	—
1:45 – 2:45	Hands-on Lab	Optimize a multi-step workflow with context management	Apply context optimization in practical tasks
2:45 – 3:00	Final Recap & Q&A	Summarize session outcomes	Reflect on overall prompting & reasoning mastery

Module Title	Session Title	Hours	No. of Sessions
Agentic AI Fundamentals	Autonomous Agents, Tool Use, Planning, Memory Systems & Safety	18	6

Session Topics Breakdown

Session **Detailed Topics**

Session 1 Agentic AI Concepts & Architecture

Session 2 Agent Workflow with Tools

Session 3 Planning and Decision Trees

Session 4 Memory & Context Retention

Session 5 Ethics & Safety in Autonomous Agents

Session 6 Practical Agent Implementation

Session 1 – Agentic AI Concepts & Architecture

Time	Section	Detailed Content / Activities	Learning Outcome
0:00 – 0:20	Welcome & Overview	Recap of Generative AI → Transition to Agentic AI	Understand the evolution from Generative to Agentic systems
0:20 – 1:00	Agentic AI Foundations	Definitions, differences between LLMs vs. Agents, capabilities	Identify key characteristics of autonomous agents
1:00 – 1:30	Agent Architecture	Core components: perception, reasoning, action, feedback	Describe agent architecture layers
1:30 – 1:45	Break	—	—
1:45 – 2:30	Case Studies	Overview of frameworks (LangChain, AutoGPT, CrewAI, OpenDevin)	Recognize real-world agent architectures

2:30 – 3:00	Q&A & Reflection	Discussion: "What makes an AI truly *agentic*?"	Connect conceptual and practical understanding

Session 2 – Agent Workflow with Tools

Time	Section	Detailed Content / Activities	Learning Outcome
0:00 – 0:30	Recap & Context	Review architecture; introduce tool usage	Recall agent components and connect to workflow
0:30 – 1:15	Tool Integration	APIs, function calling, and using external knowledge bases	Integrate tools and APIs into agent workflows
1:15 – 1:45	Action Execution	Toolchains, plug-ins, retrievers	Apply tool orchestration in agents
1:45 – 2:00	Break	—	—
2:00 – 2:45	Demo	Build a small tool-using agent via LangChain / CrewAI	Execute tool-based agent tasks
2:45 – 3:00	Recap	Summary & discussion	Reflect on workflow optimization

Session 3 – Planning and Decision Trees

Time	Section	Detailed Content / Activities	Learning Outcome
0:00 – 0:30	Introduction to Planning	Goal-based vs. reactive agents, planning paradigms	Understand decision-making models
0:30 – 1:00	Decision Trees	How agents use trees for reasoning and next-step prediction	Implement basic decision logic
1:00 – 1:30	Task Decomposition	Breaking complex goals into subtasks	Apply hierarchical planning
1:30 – 1:45	Break	—	—
1:45 – 2:45	Hands-on Lab	Build a simple planner agent	Develop agent planning capabilities
2:45 – 3:00	Q&A	Discuss limitations & future improvements	Evaluate planning strategies

Session 4 – Memory & Context Retention

Time	Section	Detailed Content / Activities	Learning Outcome
0:00 – 0:20	Introduction	Role of memory in Agentic systems	Understand memory importance
0:20 – 1:00	Memory Types	Short-term vs. long-term memory, vector stores (FAISS, Pinecone)	Identify memory mechanisms
1:00 – 1:30	Context Retention	How agents preserve state between tasks	Implement context persistence
1:30 – 1:45	Break	—	—
1:45 – 2:30	Demo & Discussion	Memory-enhanced agent examples	Analyze memory-driven interactions
2:30 – 3:00	Q&A	Reflection & summary	Evaluate trade-offs in m emory design

Session 5 – Ethics & Safety in Autonomous Agents

Time	Section	Detailed Content / Activities	Learning Outcome
0:00 – 0:20	Warm-up Discussion	“Would you trust an autonomous AI?”	Reflect on autonomy implications
0:20 – 1:00	AI Safety Overview	Key risks: misuse, misalignment, unpredictability	Recognize AI safety concerns
1:00 – 1:30	Ethical Design	Transparency, control mechanisms, human-in-the-loop	Apply responsible AI design
1:30 – 1:45	Break	—	—
1:45 – 2:30	Case Studies	Failures in autonomous systems, ethical dilemmas	Analyze ethical failures and mitigation
2:30 – 3:00	Q&A	Open discussion	Promote ethical awareness in agent design

Session 6 – Practical Agent Implementation

Time	Section	Detailed Content / Activities	Learning Outcome
0:00 – 0:20	Recap & Setup	Quick overview of components to integrate	Prepare environment for final project

0:20 – 1:30	Implementation Lab	Build an autonomous agent using LangChain / CrewAI	Build and deploy functional autonomous agents
1:30 – 1:45	Break	—	—
1:45 – 2:30	Testing & Evaluation	Run real scenarios, observe decision flow	Evaluate agent performance
2:30 – 3:00	Wrap-Up	Final discussion & reflection	Summarize and consolidate learning outcomes

Module Title	Session Title	Hours	No. of Sessions
Multi-Agent Systems	Communication, Coordination, Cooperation & Simulation in Agentic AI	18	6

Session Topics Breakdown

Session **Detailed Topics**

Session 1 Multi-Agent Fundamentals

Session 2 Coordination & Messaging Protocols

Session 3 Cooperative vs Competitive Agents

Session 4 Multi-Agent Environment Simulation

Session 5 Large-Scale Orchestration

Session 6 Capstone-Style Project Build

Session 1 – Multi-Agent Fundamentals

Time	Section	Detailed Content / Activities	Learning Outcome
0:00 – 0:20	Welcome & Recap	Quick link from Agentic AI → multi-agent evolution	Understand how agents extend into collective systems
0:20 – 1:00	Core Concepts	Definitions, agent roles, autonomy vs dependency	Define multi-agent system components

1:00 – 1:30	Agent Interaction Models	Peer-to-peer, hierarchical, swarm-based	Identify key interaction patterns
1:30 – 1:45	Break	—	—
1:45 – 2:30	Frameworks Overview	LangGraph, CrewAI, PettingZoo, MARL frameworks	Recognize multi-agent libraries
2:30 – 3:00	Discussion	"Where do we see multi-agent systems today?"	Connect concepts to real-world domains

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Session 2 – Coordination & Messaging Protocols

Time	Section	Detailed Content / Activities	Learning Outcome
0:00 – 0:30	Recap & Setup	Agent communication recap	Review communication principles
0:30 – 1:00	Messaging Protocols	Pub/Sub, request-reply, blackboard model	Understand coordination techniques
1:00 – 1:30	Agent Coordination	Scheduling, task sharing, negotiation	Apply coordination strategies
1:30 – 1:45	Break	—	—
1:45 – 2:30	Hands-on Demo	Build a basic messaging loop between two agents	Implement inter-agent communication
2:30 – 3:00	Q&A	Reflection & review	Evaluate coordination performance

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Session 3 – Cooperative vs Competitive Agents

Time	Section	Detailed Content / Activities	Learning Outcome
0:00 – 0:30	Introduction	Cooperation vs competition dynamics	Differentiate agent relationship types
0:30 – 1:00	Cooperative Systems	Shared goals, resource sharing, task allocation	Design cooperative agent strategies

1:00 – 1:30	Competitive Systems	Game theory, reward structures, adversarial tasks	Understand competition modeling
1:30 – 1:45	Break	—	—
1:45 – 2:30	Simulation Demo	Build a cooperative vs competitive scenario in simulation	Analyze agent outcomes
2:30 – 3:00	Debrief	Discussion: “What defines success for agents?”	Reflect on behavioral dynamics

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Session 4 – Multi-Agent Environment Simulation

Time	Section	Detailed Content / Activities	Learning Outcome
0:00 – 0:30	Environment Setup	Overview of simulation environments (PettingZoo, Unity ML)	Prepare environment for simulation
0:30 – 1:15	Multi-Agent Interactions	Real-time vs step-based simulation	Understand environment design
1:15 – 1:45	Break	—	—
1:45 – 2:30	Hands-on Lab	Create a simple multi-agent simulation (e.g., delivery agents)	Build and visualize interactions
2:30 – 3:00	Reflection	Analyze performance & emergent behaviors	Evaluate system complexity

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Session 5 – Large-Scale Orchestration

Time	Section	Detailed Content / Activities	Learning Outcome
0:00 – 0:20	Recap	Review small-scale systems → scalability	Understand orchestration challenges
0:20 – 1:00	Orchestration Concepts	Parallelism, load balancing, communication scaling	Identify scaling methods
1:00 – 1:30	Coordination Tools	CrewAI orchestration, vector-based scheduling	Use orchestration frameworks

1:30 – 1:45	Break	—	—
1:45 – 2:30	Lab	Deploy 4+ agents in a shared task workflow	Build multi-agent orchestration prototype
2:30 – 3:00	Review	Discuss performance, latency, coordination issues	Evaluate orchestration success factors

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Session 6 – Capstone-Style Project Build

Time	Section	Detailed Content / Activities	Learning Outcome
0:00 – 0:20	Setup	Project briefing and task allocation	Prepare for team-based project
0:20 – 1:30	Project Development	Students design and implement a full MAS	Develop end-to-end multi-agent simulation
1:30 – 1:45	Break	—	—
1:45 – 2:30	Testing & Presentation	Run simulation, measure performance metrics	Demonstrate applied understanding
2:30 – 3:00	Reflection & Feedback	Peer feedback & closing discussion	Consolidate learning outcomes

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Module Title	Session Title	Hours	No. of Sessions
RAG & Memory Systems	Retrieval-Augmented Generation, Fusion, Re-ranking & Long-Term Memory	9	3

Session Topics Breakdown

Session **Detailed Topics**

Session 1 Intro to RAG Concepts

Session 2 Advanced RAG & Fusion Methods

Session **Detailed Topics**

Session 3 Practical RAG and Memory Lab

Session 1 – Intro to RAG Concepts

Time	Section	Detailed Content / Activities	Learning Outcome
0:00 – 0:20	Warm-up & Recap	Recap of LLM context limits & intro to retrieval challenges	Understand motivation behind RAG
0:20 – 0:50	Core RAG Architecture	Definition, components (Retriever, Generator, Knowledge Store)	Describe RAG architecture and components
0:50 – 1:20	Knowledge Retrieval	Vector databases (FAISS, Chroma, Pinecone), embeddings	Implement simple retrieval workflow
1:20 – 1:35	Break	—	—
1:35 – 2:15	Workflow Example	Walkthrough: user query → document retrieval → LLM response	Map complete RAG pipeline
2:15 – 3:00	Mini-Lab	Build a simple Q&A retriever using LangChain or OpenAI API	Implement basic RAG prototype

References:

- OpenAI Developer Docs (Embeddings, Retrieval)
- LangChain Docs (Retrieval Chains)
- Papers With Code (Retrieval-Augmented Generation Benchmarks)

Session 2 – Advanced RAG & Fusion Methods

Time	Section	Detailed Content / Activities	Learning Outcome
0:00 – 0:20	Recap	Review simple RAG flow & identify pain points	Recognize RAG performance bottlenecks

0:20 – 0:50	Advanced Techniques	Multi-query retrieval, query expansion, hybrid retrieval	Understand advanced retrieval improvements
0:50 – 1:20	Fusion & Re-ranking	Fusion-in-Decoder, Re-ranking with cross-encoders	Apply ranking & fusion strategies
1:20 – 1:35	Break	—	—
1:35 – 2:15	Case Study	Compare vanilla RAG vs Fusion-RAG performance	Evaluate retrieval enhancement methods
2:15 – 3:00	Hands-on Practice	Implement hybrid retriever with re-ranking	Build and test advanced RAG pipeline

References:

- LangChain Cookbook (RAG Fusion Techniques)
- DeepMind Research (Fusion-in-Decoder paper)
- OpenAI Fine-tuning Docs (Embedding optimization)

Session 3 – Practical RAG and Memory Lab

Time	Section	Detailed Content / Activities	Learning Outcome
0:00 – 0:30	Introduction	Overview of long-term memory concepts in LLMs	Define memory augmentation principles
0:30 – 1:00	Memory Systems	Episodic, semantic, and working memory in agentic systems	Identify memory system types
1:00 – 1:30	Implementation	Add memory module to RAG pipeline using LangGraph or LangChain	Integrate memory for persistent context
1:30 – 1:45	Break	—	—
1:45 – 2:30	End-to-End Demo	Full system: RAG + memory + conversation history persistence	Develop RAG-memory hybrid application

2:30 – 3:00	Evaluation & Discussion	Discuss scaling, cost, and evaluation metrics	Assess memory-enabled RAG effectiveness

References:

- OpenAI Docs (Context & Memory)
- LangGraph Memory Nodes
- Papers With Code (Memory-Augmented RAG Systems)

Module Assessment Plan

Component	Weight	Description
Hands-on Labs	40%	Implementation of RAG pipelines and memory systems
Project Submission	40%	End-to-end retrieval and memory integration mini-project
Class Participation	20%	Contributions to discussions and reflection on ethical implications

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Module Title: Agent Deployment & Monitoring

Session Title: API Integration, Monitoring & Scaling
Hours: 9
No. of Sessions: 3

Session Topics Breakdown

Session	Detailed Topics
Session 1	- Agent deployment architecture overview- Integration via APIs and webhooks- Connecting agents with external systems (databases, apps, APIs)- Authentication and security in deployments
Session 2	- Monitoring agent performance and usage- Logging and observability tools (Prometheus, Grafana, LangSmith)- Tracking user interactions and errors- Setting up feedback loops for improvement

Session 3	- Cost optimization strategies (token management, caching, batching)- Scaling and load balancing for production- Cloud deployment options (AWS, GCP, Azure)- Case study: end-to-end deployment pipeline

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Detailed Session Plan

Session 1 — Deployment Architecture & API Integration

Time	Section	Detailed Content / Activities	Learning Outcome
0:00 – 0:20	Introduction to Agent Deployment	- Overview of agent lifecycle: development → testing → deployment- Key components of deployment architecture	Understand how agents are deployed in real-world systems
0:20 – 0:50	API Integration Basics	- REST APIs, webhooks, and JSON payloads- How agents communicate with external tools (Slack, Notion, databases)	Implement API-based communication for deployed agents
0:50 – 1:20	Secure Integration	- Managing API keys, authentication, and access control- Best practices for secure agent connections	Apply secure integration practices
1:20 – 1:30	Break		
1:30 – 2:30	Hands-on Lab	- Build and test an API-integrated agent (e.g., Chatbot connecting to weather API)- Debugging deployment errors	Deploy an agent connected to an external service
2:30 – 3:00	Recap & Discussion	- Review integration steps- Q&A	Summarize deployment and API integration concepts

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Session 2 — Monitoring & Logging Systems

Time	Section	Detailed Content / Activities	Learning Outcome
0:00 – 0:20	Importance of Monitoring	- Why monitoring matters in production- Types of metrics: latency, token usage, response accuracy	Identify critical performance metrics

0:20 – 0:50	Logging Frameworks	- Tools overview: Prometheus, Grafana, LangSmith- Logging best practices for agents	Use monitoring tools to track agent activity
0:50 – 1:20	Observability Implementation	- Implementing logs and dashboards- Detecting errors and user behavior	Build an agent observability pipeline
1:20 – 1:30	Break		
1:30 – 2:30	Practical Lab	- Monitor a deployed agent- Create custom metrics dashboard	Analyze real-time agent performance
2:30 – 3:00	Reflection	- Discussion: How monitoring improves user trust- Case study review	Understand continuous improvement through monitoring

Session 3 — Cost Optimization & Scaling Strategies

Time	Section	Detailed Content / Activities	Learning Outcome
0:00 – 0:20	Introduction to Optimization	- Token management, API cost factors- Identifying bottlenecks in pipelines	Recognize cost drivers in AI agent systems
0:20 – 0:50	Optimization Techniques	- Response caching, batching, model compression- Low-latency responses	Apply techniques to optimize performance
0:50 – 1:20	Scaling & Load Balancing	- Horizontal vs vertical scaling- Using Docker, Kubernetes for scaling- Auto-scaling strategies	Design scalable agent architectures
1:20 – 1:30	Break		
1:30 – 2:30	Case Study & Lab	- Deploy and scale an agent using cloud environment- Monitor performance under load	Implement and test scaling techniques
2:30 – 3:00	Recap & Wrap-up	- Summary of deployment → monitoring → scaling flow- Student reflection on cost–performance tradeoffs	Integrate all learned components in a full deployment workflow

Module Title: Industry Trends & AI Governance

Session Title: Course Recap, Future Trends & AI Governance
Hours: 6
No. of Sessions: 2

Session Topics Breakdown

Session	Detailed Topics
Session 1	- Recap of all previous modules (Generative AI, RAG, Agents, Deployment)- Review of key projects and practical labs- Reflection and knowledge consolidation- Group discussion: key takeaways and lessons learned
Session 2	- Global and regional AI industry trends (2025 and beyond)- AI governance and regulatory frameworks- Responsible and ethical AI in enterprises- Future skillsets and career pathways in AI

Detailed Session Plan

Session 1 — Comprehensive Recap & Knowledge Reflection

Time	Section	Detailed Content / Activities	Learning Outcome
0:00 – 0:20	Module Introduction	- Overview of session objectives- Setting expectations for recap and reflection	Recognize the purpose of revisiting and integrating course knowledge
0:20 – 0:50	Recap by Module	- Key highlights from each module: • Foundations of Generative AI • Deep Learning & Transformers • RAG & Memory Systems • Agent Design & Deployment	Summarize essential takeaways from all major modules
0:50 – 1:20	Group Reflection	- Interactive group activity: “My biggest learning insight”- Peer discussion on practical implementations	Reinforce conceptual understanding through peer learning
1:20 – 1:30	Break		

1:30 – 2:15	Showcase & Feedback	- Students present mini-project outcomes- Peer and instructor feedback session	Demonstrate application of learned AI concepts
2:15 – 3:00	Course Review & Wrap-up	- Q&A, reflection survey, final thoughts- Connecting all modules into a unified AI workflow	Integrate end-to-end understanding of the AI system lifecycle

Session 2 — AI Industry Trends & Governance Discussion

Time	Section	Detailed Content / Activities	Learning Outcome
0:00 – 0:20	Global AI Landscape	- Overview of latest trends (2025–2030): AGI, multimodal AI, autonomous agents- Market shifts and enterprise adoption patterns	Understand current and emerging AI industry trends
0:20 – 0:50	Regional Perspective	- Egypt, MENA & Africa AI strategies- National AI policies and initiatives- Discussion: local vs global innovation challenges	Relate global AI trends to local contexts
0:50 – 1:20	Governance & Regulation	- EU AI Act, U.S. frameworks, UNESCO guidelines- Data protection (GDPR), fairness & accountability	Identify major AI governance frameworks
1:20 – 1:30	Break		
1:30 – 2:00	Ethical AI & Risk Management	- Responsible AI practices and bias mitigation- Case studies of AI misuse and governance failures	Evaluate ethical and governance considerations in AI systems
2:00 – 2:45	Panel-Style Discussion	- Debate: “Can AI innovation coexist with regulation?”- Students share perspectives from business, tech, and policy viewpoints	Analyze trade-offs between innovation and governance
2:45 – 3:00	Closing Remarks	- Final wrap-up and reflection on future learning paths- Career direction advice and certification info	Identify career opportunities and continued learning pathways

Module Title: Capstone Project

Session Title: Project Planning, Implementation, Evaluation & Presentation
Hours: 6
No. of Sessions: 2

Session Topics Breakdown

Session	Detailed Topics
Session 1	- Project concept selection & planning- Team formation & role assignment- Development of core system components- Mid-project feedback & iteration
Session 2	- Final implementation & testing- Presentation preparation- Capstone showcase & evaluation- Instructor & peer feedback session

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Detailed Session Plan

Session 1 — Implementation Phase 1: Project Development & Iteration

Time	Section	Detailed Content / Activities	Learning Outcome
0:00 – 0:20	Project Overview	- Recap of capstone objectives and expectations- Review of assessment rubrics and deliverables	Understand project goals, scope, and evaluation criteria
0:20 – 0:50	Project Planning	- Define problem statement and solution scope- Identify tools, datasets, and architecture to be used	Plan an AI project from concept to prototype
0:50 – 1:20	Team Collaboration & Setup	- Assign roles (data, model, front-end, deployment)- Establish Git/GitHub project repository	Build collaborative workflows and utilize version control
1:20 – 1:30	Break		
1:30 – 2:15	Implementation – Core System	- Begin development of main system modules (data pipeline, model, or agent)- Instructor supervision and real-time mentoring	Apply generative, agentic, and RAG techniques in implementation
2:15 – 3:00	Feedback & Iteration	- Mid-project review & troubleshooting session- Reflective discussion: “What worked & what needs refinement?”	Improve project design through iteration and feedback

Session 2 — Implementation Phase 2 & Final Presentation

Time	Section	Detailed Content / Activities	Learning Outcome
0:00 – 0:30	Final Development & Testing	- Complete system integration- Conduct testing, debugging, and documentation	Finalize a functional AI solution prototype
0:30 – 1:00	Presentation Preparation	- Craft presentation slides & demos- Align team narrative and project storyline	Develop communication and presentation skills for AI projects
1:00 – 1:15	Break		
1:15 – 2:15	Capstone Showcase	- Teams present projects (10–15 min each)- Live demo of generative or agentic feature	Demonstrate applied AI knowledge in real-world context
2:15 – 2:45	Evaluation & Feedback	- Peer and instructor evaluation using defined rubric- Q&A and constructive feedback	Receive and reflect on evaluative feedback for improvement
2:45 – 3:00	Closing & Certification	- Course reflection & future roadmap- Announcement of top projects and recognition	Consolidate learning journey & celebrate project achievements