Lahore University of Management Sciences

AI-602 – Large Language Model Systems
Spring 2025

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Course URL (if any)	https://lms.lums.edu.pk/
Support Services	LUMS offers a range of academic and other services to support students. These are mentioned below, and you are encouraged to use these in addition to in-class assistance from course staff. For a complete list of campus support services available for you click here (https://advising.lums.edu.pk/#supportservices)

Course Basics				
Credit Hours	3			
Lecture(s)	Nbr of Lec(s) Per Week	1	Duration	180 minutes
Recitation/Lab (per week)	Nbr of Lec(s) Per Week	-	Duration	-

Course Distribution	
Core	No
Elective	Yes
Open for Student Category	MS AI, SSE Undergraduates and Graduates meeting pre-requisites.
Close for Student Category	--

COURSE DESCRIPTION
This course offers a practical, industry-focused journey through artificial intelligence (AI) development, from foundational concepts to deploying large language models (LLMs) for real-world applications. Students will explore essential AI lifecycle stages, including Business problem, technical problem to AI solution formulation, model training, deployment, and evaluation, with hands-on labs and case studies in natural language processing and multimodal AI. Emphasizing frameworks and tools like Docker, Kubernetes, and MLOps practices, the course prepares students to design scalable AI solutions while addressing ethical considerations and optimizing model performance. By the course's end, students will have a comprehensive understanding of AI system architecture, practical experience with LLMs, and career-ready skills, culminating in a capstone project that demonstrates their ability to create impactful AI solutions aligned with business goals.

COURSE PREREQUISITE(S)	
	AI 602: Large Language Model Systems • For MS AI students: AI500 Foundations of AI • For rest: CS 331 Introduction to AI or EE 514/CS 535/ CS 438 Machine Learning or EE 414/EE 517/ CS 437/CS 5317 Deep Learning or CS 436/ CS 5310/EE 513 Computer Vision You are required to have taken either of the above-mentioned courses or equivalent, with a satisfactory grade. Courses in Computer Vision, Natural Language Processing and Deep learning are a plus but not mandatory. Further, undergraduate-level knowledge of Calculus, Probability, and Linear Algebra is also required.

Grading Breakup and Policy
Course Breakdown: • **Labs & Assignments (15%)**   Practical exercises reinforcing course concepts.   • **Quizzes (15%)**   In-class quizzes to assess understanding.   • **Mid Exam (20%)**   A comprehensive individual exam covering all course topics.   • **Capstone Project (40%)**   A project covering problem identification through to LLM deployment.

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- **Participation (10%)**
  Active engagement in discussions and class activities.

Examination Details	
Midterm Exam	Yes/No: No Combine Separate: Duration: Preferred Date: Exam Specifications:
Final Exam	Yes/No: No Combine Separate: - Duration: - Exam Specifications: -

Campus supports & Key university policies

Campus Supports

Students are strongly encouraged to meet course instructors and TA's during office hours for assistance in course-content, understand the course's expectations from enrolled students, etc. Beyond the course, students are also encouraged to use a variety of other resources. (Instructors are also encouraged to refer students to these resources when needed.) These resources include Counseling and Psychological Services/CAPS (for mental health), LUMS Medical Center/LMC (for physical health), Office of Accessibility & Inclusion/ OAI (for long-term disabilities), advising staff dedicated to supporting and guiding students in each school, online resources (https://advising.lums.edu.pk/advising-resources), etc. To view all support services, their specific role as well as contact information click here (https://advising.lums.edu.pk/#supportservices).

Academic Honesty/Plagiarism

LUMS has zero tolerance for academic dishonesty. Students are responsible for upholding academic integrity. If unsure, refer to the student handbook and consult with instructors/teaching assistants. To check for plagiarism before essay submission, use similarity@lums.edu.pk. Consult the following resources: 1) Academic and Intellectual Integrity (http://surl.li/gpvwb), and 2) Understanding and Avoiding Plagiarism (http://surl.li/gpvwo).

LUMS Academic Accommodations/ Petitions policy

Long-term medical conditions are accommodated through the Office of Accessibility & Inclusion (OAI). Short-term emergencies that impact studies are either handled by the course instructor or Student Support Services (SSS). For more information, please see Missed Instrument or 'Petition' FAQs for students and faculty (https://rb.gy/8sj1h)

LUMS Sexual Harassment Policy
LUMS and this class are a harassment-free zone. No behavior that makes someone uncomfortable or negatively impacts the class or individual's potential will be tolerated.

To report sexual harassment experienced or observed in class, please contact me. For further support or to file a complaint, contact OAI at oai@lums.edu.pk or harassment@lums.edu.pk. You may choose to file an informal or formal complaint to put an end to the offending behavior. You can also call their Anti-Harassment helpline at 042-35608877 for advice or concerns. *For more information: Harassment, Bullying & Other Interpersonal Misconduct: Presentation (http://surl.li/gpvwt)*

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COURSE TOPICS

Week		Topics	Assessment
1	Introduction to AI, NLP, and the Industry Landscape	● The AI Landscape: History, evolution, and current state of AI. ● Introduction to Natural Language Processing (NLP) and language models. ● AI Industry Roles: AI lifecycle, career paths, and trends. ● Course Outline and Objectives. ● Exercise: Implementing a simple n-gram language model.	
2	Deep Dive into LLMs and Transformer Architectures	● Understanding Transformers and attention mechanisms. ● Exploration of models like GPT, BERT, T5, Roberta, BART etc. ● Recap of deep learning concepts: RNNs, LSTMs, and self-attention. ● Exercise: Working with pre-trained models using Hugging Face.	
3	Translating Business Problems into technical AI Problem Statement	● Frameworks for AI use case evaluation: AI Canvas, CRISP-DM. ● Techniques for translating business needs into technical requirements. ● Techniques for data collection & parsing, data augmentation, data cleaning and preprocessing. ● ROI Considerations in AI projects.	

		● Exercise: Practice with AI Canvas for structuring AI problem statements. ● Role-Play: Simulating client meetings to gather requirements.	
4	Language Understanding and Applications	● Revisit Encoder Architecture ● Essential NLP concepts: tokenization, embedding's & ● Advanced concepts: vector databases, semantic similarity, ● Use cases: Sentiment Analysis and Named Entity Recognition (NER), Retrieval Augmented Recommender Systems. ● Tools and technologies for MT, sentiment analysis, and NER. ● Lab: Building an AI solution for one of the NLP tasks.	
5	Text Generation and Comprehension	● Revisit Decoder Architecture ● Concepts in recursive text generation ● Retrieval Augmented Text Generation ● Use cases: Information Extraction, Question Answering & Text Summarization ● Tools and technologies for Text Generation. ● Exercise: Text summarization Platform	
6	Model Development & Chatbots	● Introduction to Computer Vision: CNNs and Vision Transformers. ● Multimodal AI ● Model training (supervised & unsupervised) & fine-tuning ● Prompt Engineering for Enhanced Interactions - Strategies for guiding LLMs in chatbot interactions (e.g., prompt templates, chaining prompts). ● Exercise: Building multimodal RAG Applications	
7	Conversational Flow Design and Contextual Personalization	● Agentic Frameworks in Conversational AI ● Conversational Flow Design and Dialogue Management ● Dialogue Management Approaches ● Techniques for state management in conversational agents. ● Personalization and Context-Aware Chatbots ● User History and Contextual Personalization ● Maintaining Context Within and Across Sessions ● Lab: Prompt Tuning and Contextual Frameworks ● Assignment: Implementing an Agentic Framework	
8	Evaluating AI Solutions	● Importance of evaluation in AI systems. ● Quantitative metrics: accuracy, precision, recall, F1-score, BLEU, ROUGE. ● Qualitative metrics: fluency, coherence, relevancy, readability. ● Evaluating models developed in previous labs. ● Discussion on best practices for model evaluation.	
9	Planning AI System Design and Introduction to MLOps	● AI System design fundamentals ● Data Engineering Pipelines for AI Systems ● Components of AI systems: frontend, backend, machine learning, security. ● Principles of reliability, scalability, maintainability, adaptability. ● Introduction to MLOps: Code, Data, Configs, models. ● **Activities:** Designing an AI system architecture schematic.	
10	Model Deployment and Serving	● Model training and inference pipelines. ● Tools and technologies: MLflow, Airflow, version control. ● Deployment strategies: containerization with Docker, orchestration with Kubernetes. ● PubSub for Alerting ● SQLAlchemy, FAST API, Alembic (for data migrations) ● Serving layers using Flask/Web APIs.	
11	MLOps Practices and Model Monitoring	● Code CI/CD pipelines for machine learning. ● Monitoring models in production: model drift detection, logging, alerting. ● Implementing CI/CD pipelines for an AI application. ● Setting up a model monitoring pipeline using Prometheus and Grafana	

12	System Evaluation and User Acceptance Testing	● Evaluating AI systems: data, design, and performance. ● User Acceptance Testing and feedback integration. ● Cost-benefit analysis of AI solutions. ● Activities: ● Evaluating the deployed AI system. ● Discussion on qualitative and quantitative evaluation methods.	
13	Emerging Trends & Career Dynamics	● Introduction to Cloud AWS, GCS, Azure ● Cloud Services and AI Solution on Azure & AWS ● Discussion on emerging trends: GPU's, Distributed computing ● Career Dynamics in AI: building a portfolio, resume preparation, mapping skills to industry roles. ● Workshop on career preparation. ● Discussion on the impact of emerging trends on industry practices.	
14	Project Presentations & Course Wrap Up	● Capstone Project Presentations by students. ● Course reflection, summarizing key takeaways, discussing future learning paths. ● Peer and instructor evaluations of capstone projects. ● Feedback session and course evaluation.	

Academic Honesty

The principles of truth and honesty are recognized as fundamental to a community of teachers and students. This means that all academic work will be done by the student to whom it is assigned without unauthorized aid of any kind. Plagiarism, cheating and other forms of academic dishonesty are prohibited. Any instances of academic dishonesty in this course (intentional or unintentional) will be dealt with swiftly and severely. Potential penalties include receiving a failing grade on the assignment in question or in the course overall. For further information, students should make themselves familiar with the relevant section of the LUMS student handbook.

Harassment Policy

SSE, LUMS and particularly this class, is a harassment free zone. There is absolutely zero tolerance for any behavior that is intended, or has the expected result of making anyone uncomfortable and negatively impacts the class environment, or any individual's ability to work to the best of their potential.

In case a differently-abled student requires accommodations for fully participating in the course, students are advised to contact the instructor so that they can be facilitated accordingly.

If you think that you may be a victim of harassment, or if you have observed any harassment occurring in the purview of this class, please reach out and speak to me. If you are a victim, I strongly encourage you to reach out to the Office of Accessibility and Inclusion at oai@lums.edu.pk or the sexual harassment inquiry committee at harassment@lums.edu.pk for any queries, clarifications, or advice. You may choose to file an informal or a formal complaint to put an end of offending behavior. You can find more details regarding the LUMS sexual harassment policy here.

To file a complaint, please write to harassment@lums.edu.pk.

SSE Council on Equity and Belonging

In addition to LUMS resources, SSE's **Council on Belonging and Equity** is committed to devising ways to provide a safe, inclusive and respectful learning environment for students, faculty and staff. To seek counsel related to any issues, please feel free to approach either a member of the council or email at cbe.sse@lums.edu.pk

Rights and Code of Conduct for Online Teaching

A misuse of online modes of communication is unacceptable. TAs and Faculty will seek consent before the recording of live online lectures or tutorials. Please ensure if you do not wish to be recorded during a session to inform the faculty member. Please also ensure that you prioritize formal means of communication (email, LMS) over informal means to communicate with course staff.