Subject Description Form

Subject Code	DSAI5207
Subject Title	Modern Deep Learning
Credit Value	3
Level	5
Pre-requisite/ Co-requisite/ Exclusion	Exclusion: AMA564
Objectives	This course explores modern deep learning with a focus on large-scale foundation models. Students will move beyond foundational knowledge to critically analyze, implement, and innovate upon state-of-the-art AI systems. The curriculum covers the essential principles of large model training, advanced architectures, and generative AI. Ultimately, the course prepares students for problem-solving skills for research-oriented roles, enabling them to tackle novel and complex problems.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: (a) Understand the core principles and architectures of modern deep learning, with an emphasis on large-scale and generative models. (b) Analyze complex problems and design deep learning solutions that effectively leverage or adapt state-of-the-art models. (c) Implement, fine-tune, evaluate, and deploy deep learning models using contemporary software frameworks. (d) Complete and present a research-oriented deep learning project with clear investigation and reporting.
Subject Synopsis/ Indicative Syllabus	This course explores modern deep learning through three interconnected parts: **Part 1: Modern Training Techniques.** This part explores the techniques for training modern, large-scale models. We will examine key techniques like self-supervised learning, advanced optimization methods, distributed training and parameter-efficient fine-tuning. A core focus will be on achieving computational efficiency in these large-scale training regimes. **Part 2 Modern Architectures.** This section covers contemporary architectures in deep learning. We will begin with Transformer models and their recent variants, including Vision Transformers and Mixture-of-Experts. Then, we'll explore Graph Neural Networks (GNNs) for relational data and emerging models like State Space Models and Kolmogorov–Arnold Networks. **Part 3: Modern Generative Deep Learning**. This module gives an overall introduction to leading generative models. We will cover key generative models, including Variational Autoencoders (VAEs), auto-regressive model like GPTs, and diffusion models, and flow matching models. It emphasizes both theory and implementation, along with current research trends and applications.

Teaching/Learning Methodology

Lectures: Interactive sessions will cover the core techniques of modern deep learning. The focus will be on understanding the principles behind current state-of-the-art foundation models and key research trends.

Tutorials: Hands-on lab sessions will reinforce concepts from lectures through practical application. Students will work on coding exercises involving the implementing and evaluating large-scale models.

Course Project: A team project where groups will design and present a deep learning solution, applying concepts to real-world problems.

Assessment Methods in Alignment with Intended Learning Outcomes

Specific assessment methods/tasks	% weighting	Intended subject learning outcomes to be assessed			
		a	b	c	d
1. Assignments	20%	√	√	√	
2. Course Projects	30%		√	√	√
3. Midterm Test	20%	√	√	√	
4. Final Exam	30%	√	√		
Total	100 %				

Explanation of the appropriateness of the assessment methods in assessing the intended learning outcomes:

Assignments: Tests understanding of core principles (a), problem analysis/solution design (b), and model implementation skills (c).

Course Project: Evaluates teamwork and problem-solving (b), model implementation, adaptation and evaluation (c), and systematic investigation and presentation skills (d).

Midterm: Evaluates knowledge of modern architectures and training methods (a), including analysing (b) and implementing solutions (c).

Final Exam: Measures comprehensive knowledge of architectures/theory (a) and ability to conceptualize solutions (b).

Student Study Effort Expected

Class contact:	
▪ Lectures	26 Hrs.
▪ Tutorials	13 Hrs.
Other student study effort:	
▪ Course Projects	40 Hrs.
▪ Assignment	20 Hrs.
▪ Exam Preparation/Self-Study/Practice	26 Hrs.
Total student study effort	125 Hrs.

Reading List and References	Reference Materials: 1. Goodfellow, I., Bengio, Y., Courville, A., & Bengio, Y. (2016). Deep learning (Vol. 1, No. 2). Cambridge: MIT press. 2. Bishop, C. M. (1995). Neural networks for pattern recognition. Oxford university press. 3. Prince, S. J. (2023). Understanding deep learning. MIT press. 4. Chollet, F., & Chollet, F. (2021). Deep learning with Python. Simon and Schuster. 5. Zhang, A., Lipton, Z. C., Li, M., & Smola, A. J. (2023). Dive into deep learning. Cambridge University Press.