EE4016: ENGINEERING APPLICATIONS OF ARTIFICIAL INTELLIGENCE

Effective Term
Semester B 2023/24

Part I Course Overview

Course Title
Engineering Applications of Artificial Intelligence

Subject Code
EE - Electrical Engineering
Course Number
4016

Academic Unit
Electrical Engineering (EE)

College/School
College of Engineering (EG)

Course Duration
One Semester

Credit Units
3

Level
B1, B2, B3, B4 - Bachelor's Degree

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
MA2001 Multi-variable Calculus and Linear Algebra, and
EE2331 Data Structures and Algorithms

Precursors
Nil

Equivalent Courses
Nil

Exclusive Courses
Nil

Part II Course Details

Abstract

This course will introduce the basics of Artificial Intelligence (AI) with a specific focus on deep learning, and its representative applications in engineering. In this course, students will learn the essential foundations of AI, from algorithms to programming tools. Students will gain a solid understanding of AI by building systems with modern platforms such as Python and its associated deep learning libraries.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	1. Able to describe various AI techniques and their features, with a specific focus on deep learning.		x		
2	2. Able to apply suitable deep learning techniques to solve AI engineering problems.			x	
3	3. Able to apply AI techniques to practical problems with suitable platform.			x	

A1: Attitude
Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

A2: Ability
Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to real-life problems.

A3: Accomplishments
Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

Teaching and Learning Activities (TLAs)

	TLAs	Brief Description	CILO No.	Hours/week (if applicable)
1	Lecture	Key concepts are described and illustrated. Key concepts are illustrated and worked out based on problems.	1, 2, 3	3 hrs/wk

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks (e.g. Parameter for GenAI use)
1	Tests (min. 2)	1, 2, 3	15	
2	Assignments (min. 3)	1, 2, 3	15	
3	Group Project	1, 2, 3	40	

Continuous Assessment (%)

70

Examination (%)

30

Examination Duration (Hours)
1.5

Additional Information for ATs
Remark:
To pass the course, students are required to achieve at least 30% in course work and 30% in the examination.

Assessment Rubrics (AR)

Assessment Task
Tests (15%)

Criterion
Understanding of concepts and ability to apply them successfully to solve AI engineering problems.

Excellent (A+, A, A-)
High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)
Basic

Failure (F)
Not even reaching marginal levels

Assessment Task
Assignments with programming problems (15%))

Criterion
Understanding of concepts and ability to apply them successfully to solve AI engineering problems and implement the solutions using Python and associate AI libraries.

Excellent (A+, A, A-)
High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)
Basic

Failure (F)
Not even reaching marginal levels

Assessment Task

Group Project (40%)

Criterion

1. Proposal (5%):
a. Clear project objectives and scope
b. Feasibility and methodology
c. Innovation and creativity
2. Oral Presentation (10%):
a. Effective communication of objectives, methodology, and findings
b. Engaging delivery and presentation skills
c. Understanding of the project and role within the team
3. Demonstration (5%):
a. Functionality and performance
b. Execution of project objectives
c. User experience
4. Final Report (20%):
a. Individual contributions and responsibilities
b. Relevance and depth of analysis
c. Impact on the overall project
d. Well-organized and presented report

Individual Performance Assessment of the group project is achieved by:
(a) The oral presentation assesses students' communication skills, including their ability to clearly convey project objectives, methodology, and findings. Their response to questions gauges their understanding of the project and role within the team.
(b) The final report outlines individual contributions, including responsibilities, completed tasks, and achieved outcomes. Evaluation focuses on the contributions' relevance, depth of analysis, and impact on the overall project.

Excellent (A+, A, A-)

High

Good (B+, B, B-)

Significant

Fair (C+, C, C-)

Moderate

Marginal (D)

Basic

Failure (F)

Not even reaching marginal levels

Assessment Task

Examination

Criterion

The achievement levels of the CILOs.

Excellent (A+, A, A-)

High

Good (B+, B, B-)

Significant

Fair (C+, C, C-)
Moderate

Marginal (D)
Basic

Failure (F)
Not even reaching marginal levels

Part III Other Information

Keyword Syllabus

1. History of AI
2. Basic Machine Learning
 · Introduction to regression, classification, and different types of learning paradigms (supervised, unsupervised, semi-supervised, and self-supervised learning)
 · Overview of popular machine learning algorithms and techniques
3. Neural Networks
 · Introduction to perceptrons and their role in neural networks
 · Multi-layer perceptrons (MLPs) and their architectures
 · Activation functions and loss functions used in neural networks
4. Optimizations in Deep Learning
 · Gradient descent optimization algorithm and its variants
 · Backpropagation algorithm for efficient training of neural networks
 · Regularization techniques to prevent overfitting in deep models
5. Computer Vision with Convolutional Neural Networks (CNNs)
 · Introduction to CNNs and their applications in image analysis and computer vision tasks
 · Convolutional and pooling layers in CNNs
 · CNN architectures and their variations (e.g., VGG, ResNet, Inception)
6. Natural Language Processing with Deep Learning
 · Word representation techniques (e.g., word embeddings)
 · Introduction to recurrent neural networks (RNNs) and their applications in sequence modeling
 · Attention mechanism and self-attention in deep learning models
 · Transformers and their role in natural language processing tasks
7. Pre-Trained Language Models (PLMs)
 · Overview of popular pre-trained language models such as BERT, GPT-1, GPT-2, GPT-3, BART, and T5
 · Understanding the architecture and capabilities of PLMs
 · Fine-tuning and adapting PLMs for specific tasks
8. Large Language Models (LLMs)
 · Prompt engineering techniques for controlling large language models
 · Parameter-efficient fine-tuning (PEFT) methods for optimizing large models
 · Challenges and considerations in working with large language models, including hallucination and human alignment issue

Reading List

Compulsory Readings

	Title
1	Dive into Deep Learning, Aston Zhang, Zack Lipton, Mu Li, and Alex Smola. https://d2l.ai/
2	Artificial Intelligence with Python: A Comprehensive Guide to Building Intelligent Apps for Python Beginners and Developers 1st Edition, Kindle Edition by Prateek Joshi

Additional Readings

	Title
1	Nil