ADSE4003: ARTIFICIAL INTELLIGENCE AND AUGMENTED REALITY IN MANUFACTURING AND OPERATIONS

Effective Term
Semester A 2023/24

Part I Course Overview

Course Title
Artificial Intelligence and Augmented Reality in Manufacturing and Operations

Subject Code
ADSE - Advanced Design and System Engineering

Course Number
4003

Academic Unit
Systems Engineering (SYE)

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
ADSE3003 Design and Analysis of Manufacturing Processes and Systems &
ADSE3004 Production Planning and Control

Precursors
Nil

Equivalent Courses
Nil

Exclusive Courses
Nil

Part II Course Details

Abstract

Artificial Intelligence (AI) uses big data to evolve better models, while Augmented Reality (AR) adds information to reality. Combining AI and AR realises digital twin models that virtually represents the physical attributes of a "real world" system in real-time. This course introduces the principles and concepts of applying AI and AR to manufacturing and operations that reduce operating costs and extend asset lifetime, including equipment, machines, lines, and even plants. Industry 4.0 has brought AI technologies, such as machine learning and data analytics, to manufacturing and operations that enable smart manufacturing and check orders, processes, and external factors in real-time. The collected information arms manufacturers with insights they can use to plan for diverse contingencies. Using AR in manufacturing and operations can provide a virtual representation of a real-world asset. This virtual representation is more than just a physical object model because it can continuously receive data input from the smart sensors embedded in the asset that provides a clearer picture of real-world performance and operating conditions to reduce costs. Manufacturers can also simulate the real-world environment for predictive maintenance.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Describe the difference among various AI and AR techniques, which can be used in manufacturing and operations	20	x	x	
2	Understand the principles and concepts of applying AI and AR to manufacturing and operations.	30		x	
3	Apply the knowledge of different AI and AR techniques to achieve smart manufacturing, process control and product design.	30	x	x	
4	Analyse all information collected and draw a consolidated conclusion for making decisions and planning in enterprise operation.	20	x	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 self-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	Learning through teaching is primarily based on lectures. Small-group exercises will be used to facilitate conceptual understanding of the AI and AR application to smart manufacturing.	1, 2, 3, 4	39 hours/semester
2	Laboratory	The team-based laboratory sessions allow students to learn the practical programming and control of the process flow based on signal and data feedback from smart sensors.	2, 3, 4	6 hours/semester
3	Online Tutorial	Class exercises and assignments will be discussed.	1, 2, 3, 4	7 hours/semester

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks
1	Assignments	1, 2, 3, 4	10	
2	Laboratory Work	2, 3	10	
3	Mini-Project Work	1, 2, 3, 4	20	

Continuous Assessment (%)

40

Examination (%)

60

Examination Duration (Hours)

2

Additional Information for ATs

For a student to pass the course, at least 30% of the maximum mark for the examination should be obtained.

Assessment Rubrics (AR)

Assessment Task

Test Score

Criterion

It assesses students' understanding of basic concepts in applying AI and AR applied to manufacturing and operations.

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
Laboratory Report

Criterion
It reflects students' ability to apply programming techniques and know-how to control the process flow by the sensor information feedback.

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
Mini-Project Report

Criterion
It reflects students' ability to understand and apply the concepts and theories taught in class.

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

Examination questions are designed to assess students' level of achievement of the intended learning outcomes, with balanced emphasis placed on conceptual understanding of the technology for applying AI and AR to manufacturing and operations.

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

Additional Information for AR

Examination and test will be numerically marked, and grades awarded accordingly.

Part III Other Information

Keyword Syllabus

- Concepts and Principles of AI, AR and Digital Twin
- Application of AI to Realise Smart Manufacturing
- Interaction Techniques in AR
- Application of AR to Generate Digital Twin of a Physical System
- Twin-Control Approach
- Virtual Representation and Modelling of Product and Processes
- Data Monitoring and Behaviours Management for Manufacturing Processes
- Non-intrusive Load Monitoring on Component Level of Machines
- Utilising Sensor Data for Workpiece Flaw Detection with AI
- Visualisation of Simulated and Measured Process Data in AR

Reading List

Compulsory Readings

	Title
1	Lecture notes and slides will be provided by the instructor

Additional Readings

	Title
1	ISAK KARABEGOVI, AHMED KOVAEVI, LEJLA BANJANOVI-MEHMEDOVI, PREDRAG DAI, Handbook of Research on Integrating Industry 4.0 in Business and Manufacturing (Advances in Business Information Systems and Analytics (Abisa)), IGI Global, 2020
2	S.K. ONG and A. Y. C. NEE, Virtual and Augmented Reality Applications in Manufacturing, Springer-Verlag, 2004.
3	FEI TAO, MENG ZHANG and A.Y.C. NEE, Digital Twin Driven Smart Manufacturing, Academic Press Elsevier, 2019.
4	MIKEL ARMENDIA, ERDEM OZTURK, MANI GHASSEMPOURI, FLAVIEN PEYSSON, Twin-Control: A Digital Twin Approach to Improve Machine Tools Lifecycle, Springer, 2019.