EE5606: ARTIFICIAL INTELLIGENCE FOR ANTENNAS IN WIRELESS COMMUNICATIONS

Effective Term
Semester A 2025/26

Part I Course Overview

Course Title
Artificial Intelligence for Antennas in Wireless Communications

Subject Code
EE - Electrical Engineering
Course Number
5606

Academic Unit
Electrical Engineering (EE)

College/School
College of Engineering (EG)

Course Duration
One Semester

Credit Units
3

Level
P5, P6 - Postgraduate Degree

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
Nil

Precursors
Programming training equivalent to EE2331 Data Structures and Algorithms

Equivalent Courses
Nil

Exclusive Courses
Nil

Part II Course Details

Abstract

This course aims at applying Artificial Intelligence (AI) techniques to practical antenna problems in wireless communication systems. Students will learn optimization algorithms, machine learning (ML) models, and surrogate-assisted optimizations, with a focus on solving practical antenna problems. They will learn surrogate models, including linear models, radial basis functions, and probabilistic models. Through the lectures and group project, students will know how to apply AI-driven methods to solve engineering problems, preparing them for solving challenging engineering problems and doing advanced research.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Able to explain the basic concepts of AI techniques.		x		
2	Able to formulate problems using key optimization algorithms.		x	x	
3	Able to formulate problems using key machine-learning models.		x	x	
4	Able to apply the algorithms and models to practical antenna and related problems in wireless communications.		x	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 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.

Learning and Teaching Activities (LTAs)

	LTAs	Brief Description	CILO No.	Hours/week (if applicable)
1	Lecture	To learn fundamental concepts of optimization algorithms and machine-learning models, and their applications to wireless communication systems.	1, 2, 3, 4	3 hrs/week (11 weeks)
2	Group Project and Presentation	To collaboratively learn, solve problems, and present project outputs.	2, 3, 4	3 hrs/week (2 weeks)

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks ("-" for nil entry)	Allow Use of GenAI?
1	Tests (duration: 2 hrs)	1, 2, 3, 4	25	-	No

2	Assignments	1, 2, 3	5	-	Yes
3	Projects and presentation	1, 2, 3, 4	20	-	Yes

Continuous Assessment (%)

50

Examination (%)

50

Examination Duration (Hours)

2

Minimum Continuous Assessment Passing Requirement (%)

30

Minimum Examination Passing Requirement (%)

30

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

Examination (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

Achievements in 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

Assessment Task

Coursework (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

Achievements in 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

Assessment Task
Examination (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion
Achievements in CILOs

Excellent
(A+, A, A-) High

Good
(B+, B) Significant

Marginal
(B-, C+, C) Basic

Failure
(F) Not even reaching marginal levels

Assessment Task
Coursework (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion
Achievements in CILOs

Excellent
(A+, A, A-) High

Good
(B+, B) Significant

Marginal
(B-, C+, C) Basic

Failure
(F) Not even reaching marginal levels

Additional Information for AR

Constructive Alignment with Programme Outcomes

PILO	How the course contribute to the specific PILO(s)
1, 2, 4	Students will learn fundamental concepts of optimization, machine learning, and AI-related techniques, and apply the concepts to solve practical antenna problems in modern wireless communication.
4	Students will apply the key algorithms and models to practical antenna problems in wireless communications, and the knowledge will enable them to solve other engineering problems.

Part III Other Information

Keyword Syllabus

The course will give an overview of optimization algorithms, machine learning models, and surrogate-assisted optimizations. It will emphasize applying the algorithms and models to different antenna problems in wireless communications. It includes the following topics:

1. Fundamental of optimization algorithms
   - Gradient-related optimization algorithms
   - Population-based methods
2. Fundamental of Machine Learning (ML) algorithms
   - Linear models
   - Radial basis functions (RBF)
   - Neural network (NN)
3. Fundamental of antennas
   - Antenna theory
   - Practical antennas in wireless communications
4. Antenna designs using optimization algorithms and ML models
   - Antenna optimization
   - Surrogate-assisted antenna design

Reading List

Compulsory Readings

	Title
1	Mykel J. Kochenderfer and Tim A. Wheeler, Algorithms for optimization. MIT Press, 2019.

Additional Readings

	Title
1	Zhi-Hua Zhou, Machine Learning. Springer nature, 2021.
2	John D. Kraus and Ronald J. Marhefka, Antennas for All Applications (3rd Edition). McGraw-Hill, 2002.