EE3109: APPLIED ELECTROMAGNETICS

Effective Term
Semester A 2022/23

Part I Course Overview

Course Title
Applied Electromagnetics

Subject Code
EE - Electrical Engineering
Course Number
3109

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
EE2104 Introduction to Electromagnetics
and
(MA3001 Differential Equations or EE3121 Differential Equations for Electrical Engineering)

Precursors
Nil

Equivalent Courses
Nil

Exclusive Courses
Nil

Part II Course Details

Abstract

The aim of this course is to provide students with fundamental electromagnetic theories and techniques for working as a communication engineers.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Apply the Maxwell's equations to find the E-field from the H-field and vice versa			x	
2	Apply the boundary conditions to find the EM fields for simple problems		x	x	
3	Analyze the incident and reflected waves in a transmission line			x	
4	Match a load to the system impedance			x	
5	Design a simple half wavelength dipole			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	Explain lecture notes. Problems and solutions are discussed.	1, 2, 3, 4, 5	3 hrs /wk
2	Laboratory	Practical implementation and understanding of lecture materials	1, 2, 3, 4, 5	3 hrs/wk (2 weeks lab)
3	Assignments, group discussion, self-study	Three assignments are given	1, 2, 3, 4, 5	

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks (e.g. Parameter for GenAI use)
1	Tests (min.: 2)	1, 2, 3, 4, 5	30	
2	#Assignments (min.: 3)	1, 2, 3, 4, 5	10	
3	Lab Exercises/Reports	1, 2, 3, 4, 5	10	

Continuous Assessment (%)
50

Examination (%)
50

Examination Duration (Hours)
2

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. Also, 75% laboratory attendance rate must be obtained.

may include homework, tutorial exercise, project/mini-project, presentation

Assessment Rubrics (AR)

Assessment Task
Examination

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

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

Part III Other Information

Keyword Syllabus

Electromagnetic Wave Propagation

Revision of time harmonic analysis; Gauss', Ampere's, and Faraday's laws. Conduction and dielectric losses, loss tangent. Displacement current and Maxwell's equations. Plane wave propagation in a homogeneous medium, propagation constant, intrinsic impedance. Wave polarization, circularly polarized waves, axial ratio.

Reflection, Refraction, and Transmission

Boundary conditions. Wave reflection, refraction, and transmission at a dielectric-dielectric interface, Snell's Law. Phase and group velocities, standing waves, total internal reflection. Multiple reflections, quarter-wave coating. Reflection of polarized waves, Brewster angle. Wave reflection from a plane of conductor.

Transmission Lines

Wave propagation in a terminated transmission line, phase velocity, attenuation constant. Circuit parameters of typical transmission lines. Characteristic impedance, reflection coefficient, voltage standing ratio. Power transfer, impedance matching, Smith chart. Multiple reflections, quarter-wave transformer. Dielectric waveguide.

Radiation

Fresnel and Fraunhofer zones, radiation conditions. Radiation of a tiny current element, a half wavelength dipole, and a patch antenna. Radiation pattern, radiation resistance, beamwidth, bandwidth, gain, and directivity. Power transfer, effective isotropic radiation power, antenna aperture, Friss transmission formula.

Reading List

Compulsory Readings

	Title
1	F. T. Ulaby and U. Ravaioli: Fundamentals of Applied Electromagnetics (Pearson, 7th Ed., 2015)

Additional Readings

	Title
1	Ida, Nathan: Engineering Electromagnetics (Springer, 3rd Ed., 2015)
2	W Hayt and J Buck: Engineering Electromagnetics, (McGraw Hill, 8th Edition, New York, 2010)
3	S. J. Orfanidis: Electromagnetic Waves and Antennas (2008) (Available online: www.ece.rutgers.edu/~orfanidi/ewa)