EE4804: ANTENNA DESIGN FOR INTEGRATED CIRCUITS

Effective Term
Semester A 2022/23

Part I Course Overview

Course Title
Antenna Design for Integrated Circuits

Subject Code
EE - Electrical Engineering
Course Number
4804

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

Precursors
Nil

Equivalent Courses
Nil

Exclusive Courses
Nil

Part II Course Details

Abstract

This course aims to provide students with essential techniques for the analysis and design of antennas for integrated circuits. Emphasis is placed on the understanding of principles of operation. Basic high-frequency engineering modelling and measurement techniques will be learned.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Describe and analyze radiation characteristics of antenna sources		x	x	
2	Identify and analyze various types of antennas and antenna arrays		x	x	
3	Describe the general characteristics of off-chip and on-chip antennas		x	x	
4	Describe technologies for antenna in package (AiP) on semiconductors		x	x	
5	Design antennas for integrated circuits (ICs)		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.

Teaching and Learning Activities (TLAs)

	TLAs	Brief Description	CILO No.	Hours/week (if applicable)
1	Lecture	Background, basic theory, analysis, measurement techniques. Exercises on basic analysis and practical designs	1, 2, 3, 4, 5	3 hrs/week
2	Lab for Mini-project	Simulation on off-chip and on-chip antenna characteristics, design of antennas on ICs.	3, 4, 5	3 hrs/week (3 weeks)

Assessment Tasks / Activities (ATs)

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

Continuous Assessment (%)

60

Examination (%)

40

Examination Duration (Hours)

2.5

Additional Information for ATs

Remark:
To pass the course, students are required to achieve at least 30% in the coursework and 30% in the examination. Also, 75% laboratory attendance rate must be obtained.

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

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

Electrical Properties and Characteristics for Antennas

Impedance characteristics of antennas, radiation characteristics of antennas, gain and efficiency of antennas, polarization of wave, wave reflection and transmission

Gain and Bandwidth Enhancements for Antennas

Arrays, reflectors, transmitters, Fabry-Perot Cavity, steering-beam arrays, multiple-beam arrays, L-probe antennas, U-slot antennas, magneto-electric dipole antennas, Vivaldi antennas, complementary antennas

Off-Chip and On-Chip Antennas

Printed antennas, substrate-integrated-waveguide antennas, LTCC antennas, chip-dielectric antennas, lens antennas, on-chip antenna sources, full-wave electromagnetic modelling for IC

Technologies for antenna-in-package (AiP)

Filip-chip process, wire bonding, ball grid array for AiP, AiP modules, impedance transform for AiP, AiP measurements

Antenna Design for ICs

Microwave antennas and arrays for ICs, millimeter-wave antennas and arrays for ICs, terahertz antennas and arrays for ICs

Reading List

Compulsory Readings

	Title
1	Hammad M. Cheema, Fatima Khalid, Atif Shamim, “Antenna-on-Chip: Design, Challenges, and Opportunities”, 2020, Artech House, ISBN: 9781608078189
2	K. C. Gupta, and P. S. Hall, “Analysis and Design of Integrated Circuit-Antenna Modules”, 1999, Wiley, ISBN-13: 978-0471190448

Additional Readings

	Title
1	T. Mitch Wallis, “Measurement Techniques for Radio Frequency Nanoelectronics”, 2017, The Cambridge RF and Microwave Engineering Series
2	C A Balanis, “Antenna Theory-Analysis and Design”, 2005, John Wiley & Sons, New York, 3rd Edition
3	K F Lee and W Chen, “Advances in Microstrip and Printed Antennas”, 1997, John Wiley & Sons, New York