EE5425: FUNDAMENTALS OF RADIO FREQUENCY (RF) CIRCUIT ENGINEERING

Effective Term
Semester A 2025/26

Part I Course Overview

Course Title
Fundamentals of Radio Frequency (RF) Circuit Engineering

Subject Code
EE - Electrical Engineering
Course Number
5425

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
EE3109 Applied Electromagnetics; or equivalent

Equivalent Courses
EE6425 Fundamental of Radio Frequency (RF) Circuit Engineering

Exclusive Courses
Nil

Part II Course Details

Abstract

This course aims to provide students with essential circuit design and measurement techniques in wireless communication devices and radio frequency applications

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Recognize basic RF circuits.		x		
2	Apply S-parameters, transmission line theory and Smith chart for impedance matching.		x	x	
3	Measure RF circuits using Network Analyzers and Spectrum Analyzers.		x	x	
4	Design small signal RF amplifiers.		x	x	
5	Simulate RF passives and amplifiers using CAD tools and evaluate their performances.		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/tutorial	To deliver key concepts, facilitate discussions, and guide students through problem-solving exercises. To allow students to actively engage with the subject matter, ask questions and receive feedback.	1, 2, 4	3 hrs/wkfor 10 weeks
2	Laboratory	To perform measurements of an RF/ microwave circuit using a Network Analyzer. To demonstrate nonlinear effects at RF/microwave frequencies. Simulation of RF/Microwave circuits using CAD tools and evaluate their performance.	3, 4, 5	3 hrs/wkfor 3 weeks

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks ("-" for nil entry)	Allow Use of GenAI?
1	Tests (min.: 1)	1, 2, 4	20	-	No
2	#Assignments (min.: 3)	1, 2, 4	20	-	Yes
3	Lab Exercises/ Reports	2, 3, 4, 5	10	-	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. Also, 75% laboratory attendance rate must be obtained.
may include homework, tutorial exercise, project/mini-project, presentation

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 level

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 level

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) Medium

Marginal
(B-, C+, C) Low

Failure
(F) Not even reaching marginal level

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) Medium

Marginal
(B-, C+, C) Low

Failure

(F) Not even reaching marginal level

Additional Information for AR

Constructive Alignment with Programme Outcomes

PILO 1 - The course provides students with general knowledge about RF/microwave active circuits and their measurements.
PILO 2,3 - Students are required to do an impedance matching exercise that will allow them to put theory into practice.
PILO 4 - Students will be required to do two mini-projects that will require them to design an RF passive and an RF amplifier and evaluate their performances.
PILO 5 - Students will be required to design, simulate, fabricate and measure the RF passives.

Part III Other Information

Keyword Syllabus

Introduction to RF/Microwave Engineering
Review of fundamental issues of RF/Microwave engineering.
Existing key applications.

Basic Theoretical Skills for RF/Microwave Engineering
Transmission Lines and telegrapher’ s equation.
Impedance and admittance Smith chart.
Microwave network parameters, such as Z-parameters, Y-parameters, S-parameters, and ABCD matrix.

Classic Impedance Matching
Quarter wavelength transformer.
Lumped-element matching.
Single stub matching.

Measurement Methods at RF/Microwave Frequencies
Frequency domain measurements using a spectrum analyzer.
S-parameter measurements using a network analyzer.

RF/Microwave Passive Components
RF passive components and even/odd mode analysis.
Fundamentals of RF filters.

Microwave Control Devices
Microwave Switches
Microwave phase shifters
Microwave attenuators

RF/Microwave Amplifiers
Fundamental Concepts for RF Amplifiers: Noise power, noise figure and noise factor, 1dB gain compression point, intermodulation distortion and third order intercept point.
Review of static characteristics of RF bipolar junction and field effect transistors and their models.
Design of maximum gain amplifiers.
Design of constant gain amplifiers
Design of low noise amplifiers .
RF Oscillators
Microwave oscillator specifications: frequency stability and phase noise
One-port design approach
Two-port design approach

RF Mixers
Nixing principles and specifications
Mixer design with a hybrid
Image frequency and rejection

Reading List

Compulsory Readings

	Title
1	Lecture notes
2	David Pozar, Microwave Engineering, 4th Edition, Wiley.

Additional Readings

	Title
1	Guillermo Gonzalez: Microwave Transistor Amplifiers: Analysis and Design (2nd Edition, Prentice Hall, 1997)
2	George D. Vendelin: Microwave Circuit Design Using Linear and Nonlinear Techniques, (Wiley 2005).