EE4107: 5G CIRCUIT DESIGN

Effective Term
Semester A 2023/24

Part I Course Overview

Course Title
5G Circuit Design

Subject Code
EE - Electrical Engineering
Course Number
4107

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
EE2005 Electronic Devices and Circuits or
EE2301 Basic Electronic Circuits

Precursors
EE3109 Applied Electromagnetics

Equivalent Courses
Nil

Exclusive Courses
Nil

Part II Course Details

Abstract

This course provides students with an overview understanding and essential techniques for designing electromagnetic circuits at mm-wave, microwave and radio frequencies (RF). These circuits are of importance to the design of 5G wireless products and other applications for cutting-edge mobile and high-speed electronic devices. This course introduces students to theoretical and software tools used to analyse and design the aforementioned circuits, and gain an understanding on the passive and active building blocks to microwave circuits, such as ones used in a 5G mobile phone. This course also gives students exposure to the practical fabrication and testing of such high-frequency microwave circuits.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Describe general knowledge of microwave and wireless technologies, and the infrastructure of RF Front-Ends		x	x	
2	Design simple microwave and RF circuits using microwave transmission line theory and network theory		x	x	
3	Analyze basic passive components in microwave and RF		x	x	
4	Describe the general considerations in designs of active circuitry		x	x	
5	Design basic active microwave and RF circuits		x	x	
6	Construct simple RF and microwave circuits based on a given specification.		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	Key concepts and approaches of analysis are provided. Problems based teaching and learning.	1, 2, 3, 4, 5, 6	3 hrs/wk

2	Laboratory Session	Practical session involving an experimental approach.	1, 2, 4, 5, 6	3hrs/wk (2 weeks)

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks (e.g. Parameter for GenAI use)
1	Tests (min.: 2)	1, 2, 3, 4, 5	40	
2	#Assignments (min.: 3)	1, 2, 3, 4, 5, 6	20	

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 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

Tests

Criterion

Intermediate stage: ability to demonstrate their knowledge in RF circuits for 5G

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

Assignments

Criterion
Ability to demonstrate their grasp on course concepts and their ability to apply and/or integrate these concepts.

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
Ability to demonstrate their knowledge in RF circuits for 5G.

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
Microwave Circuit in a 5G Mobile Device: Overview of a 5G mobile device; power, noise and bandwidth considerations; key components in an RF front end.

Transmission Lines: Types of transmission lines; transmission line theory; terminated transmission lines.

Microwave Network Analysis: Z-matrix, Y-matrix, ABCD matrix, S-matrix, matrix conversion; cascaded networks; signal flow graphs.

Impedance Matching: Power flow; impedance transformation; Smith charts: L-sections, single-stub tuning.

Overview on Filters: Frequency response of microwave circuits, filter topologies, filter functionalities, filter designs and transformations.

Overview on Active Microwave Circuits: Noise and stability analysis; power transfer and gain; microwave amplifiers: classification, biasing, efficiency, gain circles, amplifier design.

Other Topics: Multi-port passive microwave networks (power dividers, circulators, couplers); Oscillators; Fabrication and characterization of microwave circuits.

Reading List

Compulsory Readings

	Title
1	Reinhold Ludwig and Gene Bogdanov: RF Circuit Design: Theory and Applications, (Pearson, 2nd Edition, 2008)

Additional Readings

	Title
1	David Pozar: Microwave Engineering, (Wiley, Hoboken, New Jersey, 4th Edition, 2012)
2	Mathew M Radmanesh: Radio Frequency and Microwave Electronics Illustrated, (Prentice Hall, 2001)
3	S Y Liao: Microwave Devices and Circuits, (Prentice Hall, New Jersey, 3rd Edition, 1990)