

EE6426: RADIO FREQUENCY (RF) CIRCUIT ENGINEERING

Effective Term

Semester B 2024/25

Part I Course Overview

Course Title

Radio Frequency (RF) Circuit Engineering

Subject Code

EE - Electrical Engineering

Course Number

6426

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

EE5425 Fundamentals of Radio Frequency (RF) Circuit Engineering; or EE6425 Fundamentals of Radio Frequency (RF) Circuit Engineering; or equivalent

Precursors

Nil

Equivalent Courses

Nil

Exclusive Courses

Nil

Part II Course Details

Abstract

This course aims to acquire the fundamental concepts, basic theory of advanced circuit design and important techniques in radio frequency circuits.

Course Intended Learning Outcomes (CILOs)

CILOs		Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Able to apply basic linear and non-linear techniques to RF circuits.		x	x	
2	Able to differentiate between non-linear modes of operation.		x	x	
3	Able to design modern power amplifiers oscillators and mixers.		x	x	x
4	Able to apply measurement techniques to large signal devices.		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	Key concepts of RF receivers and transmitters, large signal amplifier, oscillator, and non-linear RF circuits and applications will be illustrated in part. Students will be engaged with the solution to the remaining parts of the illustration leading to problems for students to discover through self-learning after class.	1, 2, 3	2 hrs/wk

2	Tutorial	Students will be given problems to solve in the lectures. Between lectures and tutorials, students will find ways to solve these problems so that in the tutorials, they will present and discuss their solutions.	1, 2, 3	1hr/wk (Some of the tutorials will be conducted in the laboratory)
3	Mini-Project	Students will be formed into small groups to design a circuit to a given specification. Students will assign themselves different tasks to work separately and together as a group. They will be challenged to aim for the best performance using their creativity in design.	1, 2, 3, 4	

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	20	

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.

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, 2, 3, 4 The course provides students opportunities in acquiring knowledge of and evaluation of RF circuit design, and also the applications of basic concept and skills for RF engineering problem solving

Part III Other Information**Keyword Syllabus****RF Receiver and Transmitter**

- RF receiving system, design consideration and examples.
- RF transmitting system, design consideration and examples.
- Heterodyne and zero-IF systems, Basic measurement for transmission and reception.

Large Signal Amplifier

- Classes of operation and their characteristics.
- Design considerations of power amplifier.
- Efficiency enhancement.
- Large signal scattering parameters and measurement.

Oscillator

- Theory of oscillation.
- Oscillator design, VCOs.
- Frequency stabilised oscillator.

Non-linear RF Circuits and applications

- Passive and active mixers.
- Passive and active detectors.
- Frequency multiplication.
- Frequency up-conversion and down-conversion.

Reading List**Compulsory Readings**

Title	
1	Reinhold Ludwig & Pavel Bretchko: RF Circuit Design (Prentice Hall)
2	G Vendelin, A Pavo& U Rohde : Microwave Circuit Design Using Linear and Nonlinear Techniques (John Wiley & Sons, 1990)

3	Herbert L Krauss, Charles W Bostian & Frederick H Raab: Solid State Radio Engineering (John Wiley & Sons, 1980)
4	Ravender Goyal, : High-Frequency Analogue Integrated Circuit Design (John Wiley & Sons, Inc., 1995)

Additional Readings

	Title
1	Christian Gantili : Microwave Amplifiers and Oscillators (North Oxford Academic, 1986)
2	Irving M & Gottlieb P E :Solid-State High-Frequency Power (Reston Publishing Co. Inc. A Prentice-Hall Co., 1982)
3	Stephen Maas : Microwave Mixers (Artech House, 1988)
4	Stephen Maas : Non-linear Microwave Circuits (Artech House, 1988)
5	Gary M Miller : Modern Electronic Communication (Prentice-Hall, 1988)
6	K Clark & D Hess : Communication Circuit Analysis and Design (Addison-Wesley, 1971)
7	Stephen Erst : Receiving Systems Design (Artech House, 1984)
8	Ferenc Kovacs : High Frequency Application of Semiconductor Devices (Elsevier Scientific Publishing Co, 1981)
9	R S Carson : High Frequency Amplifiers (Wiley, 1982)
10	G Vendelin : Design of Amplifiers and Oscillators by the S parameter Method (Wiley, 1982)
11	K Chang : Hand book of Microwave and Optical Components, vol. 1 (Wiley, 1990)
12	Morris Engelson : Modern Spectrum Analyser Theory and application (Artech House, 1984)