City University of Hong Kong
Course Syllabus

offered by Department of Electrical Engineering
with effect from Semester A in 2022/2023

Part I Course Overview

Course Title:	Fundamentals of Radio Frequency (RF) Circuit Engineering
Course Code:	EE5425
Course Duration:	One Semester (13 weeks)
Credit Units:	3
Level:	P5
Medium of Instruction:	English
Medium of Assessment:	English
Prerequisites: *(Course Code and Title)*	Nil
Precursors: *(Course Code and Title)*	EE3109 Applied Electromagnetics and EE3110 Analogue Electronics; or equivalent
Equivalent Courses: *(Course Code and Title)*	EE6425 Fundamental of Radio Frequency (RF) Circuit Engineering
Exclusive Courses: *(Course Code and Title)*	Nil

Part II Course Details

1. Abstract

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

2. Course Intended Learning Outcomes (CILOs)

(CILOs state what the student is expected to be able to do at the end of the course according to a given standard of performance.)

No.	CILOs	Weighting (if applicable)	Discovery-enriched curriculum related learning outcomes (please tick where appropriate)		
			A1	*A2*	*A3*
1.	Recognize basic RF circuits.		✓		
2.	Apply S-parameters, transmission line theory and Smith chart for impedance matching.		✓	✓	
3.	Measure RF circuits using Network Analyzer and Spectrum Analyzer.		✓	✓	
4.	Design small signal RF amplifiers using gain circles.		✓	✓	
5.	Simulate RF amplifiers using CAD tools, fabricate, and measure their performances.		✓	✓	✓
		100%			

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 self-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.

3. Teaching and Learning Activities (TLAs)

(TLAs designed to facilitate students' achievement of the CILOs.)

TLA	Brief Description	CILO No.						Hours/week (if applicable)
		1	2	3	4	5		
Lecture/tutorial	Theory and basic concepts to be taught in a lecture style and reinforced with problem solving and interactive questioning.	✓	✓	✓	✓			3 hrs/wk *for 13 weeks*
Laboratory	Measurements of an RF/microwave circuit using Network Analyzer. To demonstrate effects at RF/microwave frequencies. Simulation of RF/Microwave circuits using CAD tools.		✓			✓		3 hrs/wk *for 3 weeks*

4. Assessment Tasks/Activities (ATs)

(ATs are designed to assess how well the students achieve the CILOs.)

Assessment Tasks/Activities	CILO No.						Weighting	Remarks
	1	2	3	4	5			
Continuous Assessment: 60%								
Tests (min.: 2)	✓	✓		✓			36%	
#Assignments (min.: 3)	✓	✓		✓			12%	
Lab Exercises/Reports		✓	✓	✓	✓		12%	
Examination: 40% (duration: 2hrs , if applicable)								
Examination	✓	✓		✓			40%	
							100%	

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

5. Assessment Rubrics

(Grading of student achievements is based on student performance in assessment tasks/activities with the following rubrics.)

Applicable to students admitted in Semester A 2022/23 and thereafter

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B,)	Marginal (B-, C+, C)	Failure (F)
1. Examination	Achievements in CILOs	High	Medium	Low	Not even reaching marginal level
2. Coursework	Achievements in CILOs	High	Medium	Low	Not even reaching marginal level

Applicable to students admitted before Semester A 2022/23

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B, B-)	Fair (C+, C, C-)	Marginal (D)	Failure (F)
1. Examination	Achievements in CILOs	High	Significant	Moderate	Basic	Not even reaching marginal level
2. Coursework	Achievements in CILOs	High	Significant	Moderate	Basic	Not even reaching marginal level

6. Constructive Alignment with Programme Outcomes

PILO	How the course contribute to the specific PILO(s)
1	The course provides students with general knowledge about RF/microwave active circuits and their measurements.
2,3	Students are required to do an impedance matching exercise that will allow them to put theory into practice.
4	Students will be required to do a mini-project that will require them to assess and evaluate a solution to an RF amplifier design problem.
5	In the same mini-project, students will be required to simulate, design, fabricate, and measure their solution for an RF amplifier.

Part III Other Information (more details can be provided separately in the teaching plan)

1. 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 wave propagation.
Reflection and transmission coefficient.
Impedance and admittance Smith chart.
S-parameters, Y-parameters and indefinite admittance matrix.

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

Classic Impedance Matching
Ell matching.
Quarter wavelength transformer.
Single stub matching.
Double stub matching.

Components at RF/Microwave Frequencies
Behavior and modelling of passive elements such as resistor, capacitor and inductor.
Review of static characteristics of bipolar junction and field effect transistors.
Transistors at RF and their models.

Classic Design of Small Signal RF/Microwave Amplifier
Transducer gain, unilateral transducer gain, available gain, power gain and stability factor.
Choice of bias, biasing and stabilization circuits.
Noise figure and its measurements, noise figure of cascaded 2-ports.
1dB gain compression point, intermodulation distortion and third order intercept point.
General purpose amplifier design using unilateral transducer gain circles.
Low noise amplifier design using available gain and noise figure circles.
Amplifier design using power gain circles.

2. Reading List

2.1 Compulsory Readings

(Compulsory readings can include books, book chapters, or journal/magazine articles. There are also collections of e-books, e-journals available from the CityU Library.)

1.	Lecture notes
2	Guillermo Gonzalez: Microwave Transistor Amplifiers: Analysis and Design, (2nd Edition, Prentice Hall, 1997)

2.2 Additional Readings

(Additional references for students to learn to expand their knowledge about the subject.)

1.	T. C. Edwards: Foundations for Microstrip Circuit Design, (Wiley, 2016)
2.	George D. Vendelin: Microwave Circuit Design Using Linear and Nonlinear Techniques, (Wiley 2005).
3.	W. K. Chen: Broadband Matching - Theory and Implementations, (World Scientific, 1988)
4.	T. T. Ha: Solid-State Microwave Amplifier Design, (John Wiley & Sons 1981)