University of Macau

Faculty of Science and Technology

Department of Electrical and Electronics Engineering

Part A: Course Outline

Course Title	Telecommunication Electronics		
Course Code	ELEC440	Year of Study:	3
Course Mode	Theoretical with substantial laboratory/ practice content		
Compulsory/Elective	Elective		
Course Prerequisites	ELEC240, ELEC321, ELEC361		
Prerequisite Knowledge	Circuit Analysis, fundamental electronics circuits, electromagnetic, telecommunication, radiation and propagation		
Class/Laboratory Schedule	3-hours lecture, 1.5-hours tutorial and 0.5-hour experiment per week		
Duration	One semester	Credit Units	3.5
Text Books and References	[1] R. Ludwig and P. Bretchko, *RF Circuit Design Theory and Applications*, Prentice-Hall, 2000. [2] A. S. Sedra and K. C. Smith, *Microelectronics Circuits*, 5th Edition, Oxford University Press, 2004. [3] P. A. Rizzi, *Microwave Engineering Passive Circuits*, Prentice-Hall, 1988. [4] D. M. Pozar, *Microwave Engineering*, Addison-Wesley, 1990. [5] M. W. Medley, *Microwave and RF Circuits: Analysis, Synthesis and Design*, Artech House, 1993. [6] G. L. Matthaei, L. Young and E. M. T. Jones, *Microwave Filters, Impedance-Matching Networks, and Coupling Structures*, McGraw-Hill, 1964.		
Course Description	This course deals with the architecture and RF design techniques for receivers and transmitters used in modern wireless analog and digital communication systems. Nonlinear circuit analysis, CAE, and device modeling essential for the design and analysis of large signal elements such as power amplifiers, oscillators, mixers, modulators, and limiters as well as distortion effects in small signal elements such as LNAs will be presented. The focus of the course is not only the basic linear RF circuits using *S*-parameters but also their application in modern transceiver design which also involves the some non-linear effects discussion. Another important consideration is circuit layout; therefore some problems caused by coupling, grounding and parasitic resistance are also explored. Narrowband and broadband designs are compared, using lossless and lossy impedance matching as well as feedback circuit. Low-noise amplifier design is also		

	illustrated, discussing trade-offs amongst gain flatness, noise and impedance match. Throughout out the course, both linear and nonlinear circuits are given comparable balanced treatment in order to give students the prospectus in modern RF circuits and its latest investigations.
Topics Covered	1. Introduction to RF/MW 2. Passive Filter Design 3. Active Component and Its Modeling 4. Amplifier Design
Course Objectives	1. To study the concept of RF/Microwave circuit theory. [a, e, h, k] 2. To provide the design consideration of passive microwave circuit devices. [a, e, h, k] 3. To study the active components in wireless communications. Properties and design consideration are taught. [a, b, c, e, h, k] 4. To study the basics of amplifiers, usage and also the design process. The specification in design consideration and trade-off are also introduced. [a, b, c, e, h, k, l]
Course Assessment	Quiz: 15% Experiments: 30% Mid-term Exam. : 25% Final Exam. : 30%
Relationship to Program Objectives and Outcomes	This course primarily contributes to EEE program outcomes that develop students abilities to: a. Ability to apply knowledge of mathematics, science and engineering. b. Ability to design and conduct experiments. e. Ability to identify, formulate and solve engineering problems. k. Ability to use the techniques, skills and modern engineering tools necessary for engineering practice. This course secondarily contributes to EEE program outcomes that develop students abilities to: c. Ability to design a system, component or process to meet desired needs. h. Broad education necessary to understand the impact of engineering solutions in global and societal context. l. Ability to use the computer/IT tools relevant to the discipline along with an understanding of their processes and limitations.

<table>
<tr><td>Course Contents and Relationship to Program Criteria</td><td>
<table>
<tr><th>Week no.</th><th>Topics</th><th>Program Criteria</th></tr>
<tr><td>5</td><td>Introduction to RF/MW
Importance of high frequency circuit design; Transmission line fundamentals; Smith chart; Scattering parameters; Single- and multiport networks; Network analyzer measurements; RF CAE.</td><td>DIC, ES, DE, LA, CV</td></tr>
<tr><td>3</td><td>Passive Filter Design
Passive filter vs. active filter; Basic resonator and filter configuration; Component losses and parasitics; Quality factor Q and bandwidth consideration; Filter approximation; Filter implementation; Transformation to highpass, bandpass and bandstop response; Coupled filters; Diplexer filters and examples.</td><td>DIC, ES, CV</td></tr>
<tr><td>2</td><td>Active Component and Its Modeling
Active circuit limitation; Harmonic and intermodulation distortion; Gain compression & dynamic range; High frequency Diode and transistor; Linear and non-linear models; Scattering parameter device characterization.</td><td>DIC, ES, DE, CV</td></tr>
<tr><td>4</td><td>Amplifier Design
Linear amplifier design; Matching and biasing network; Amplifier power relations; Stability consideration; Noise figure circles; Trade-offs between gain and noise performance; Feedback amplifiers combined with impedance matching; Feedback effects on stability and noise; Broadband, high-power and multistage amplifiers.</td><td>DIC, ES, CV</td></tr>
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<tr><td>Contribution of Course to meet the professional component</td><td>This course deals with the architecture and RF design techniques for receivers and transmitters used in modern wireless analog and digital communication systems. Nonlinear circuit analysis, CAE, and device modeling essential for the design and analysis of large signal elements such as power amplifiers, oscillators, mixers, modulators, and limiters as well as distortion effects in small signal elements such as LNAs will be presented.</td></tr>
<tr><td>Course Instructor(s)</td><td>Prof. Tam Kam Weng</td></tr>
<tr><td>Prepared by</td><td>Prof. Tam Kam Weng</td></tr>
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Part B: General Course Information and Policies

Instructor: Prof. Tam Kam Weng Office: N323
Office Hour: By appointment Ext.: 4373
E-mail: kentam@umac.mo

Programme Educational Objectives

1. **Problem Solving:** Graduates have the ability to think in a critical and evaluative manner and to consider a broad perspective, in order to solve technical and nontechnical problems.
2. **Leadership and Communication:** Graduates will provide effective leadership, act in an ethical manner and skills will include the ability to communicate well and to work successfully within diverse groups.
3. **Market Acceptance:** Graduates will have successful careers in the academic environment, industrial and government organizations.
4. **Technical Competence:** Graduates will be technically competent and have a thorough grounding in the fundamentals of math and science in electrical and electronics engineering and experience in engineering design. They will be able to use modern engineering techniques, skills, and tools to fulfill societal needs.

Scale: 1 (Highest) to 4 (Lowest)

	Problem Solving	**Leadership and Communication**	**Market Acceptance**	**Technical Competence**
Telecommunication Electronics	1	3	2	1

Remark:

- Objective for “Problem Solving” can be achieved by assignments, quizzes, mid-term exam and final exam.
- Objective for “Leadership and Communication” can be achieved by experiments. However, leadership training is not given by this course.
- Objective for “Market Acceptance” can be achieved as this course provides fundamental knowledge in electronics.
- Objective for “Technical Competence” can be achieved by using fundamentals of math and science in electrical and electronics engineering and experience in engineering project design and computer simulation.

Program Criteria Policy:

Course VS Program Criteria

Scale: 5 (Highest) to 1 (Lower)

Course	PS	DIC	BS	CS	ES	DE	LA	CV	DM
Telecommunication Electronics		4			5	3	2	4	

Terms:

Probability and Statistics (PS), Differential and Integral Calculus (DIC), Basic Science (BS), Computer Science (CS), Engineering Science (ES), Differential Equation (DE), Linear Algebra (LA), Complex Variables (CV), Discrete Mathematics (DM)

Program Outcome Policy:

Course VS Course Outcomes

(H= Highly Related, S = Supportive, N = None)

Course	a	b	c	d	e	f	g	h	i	j	k	l
Telecommunication Electronics	H	H	S	N	H	N	N	S	N	N	H	H

The electrical and electronics engineering program outcomes are:

a. Ability to apply knowledge of mathematics, science and engineering.

b. Ability to design and conduct experiments.

c. Ability to design a system, component or process to meet desired needs.

d. Ability to function on multidisciplinary teams.

e. Ability to identify, formulate and solve engineering problems.

f. Understanding of professional and ethical responsibility.

g. Ability to communicate effectively.

h. Broad education necessary to understand the impact of engineering solutions in global and societal context.

i. Recognition of the need for and an ability to engage in life-long learning.

j. Knowledge of contemporary issues.

k. Ability to use the techniques, skills and modern engineering tools necessary for engineering practice.

l. Ability to use the computer/IT tools relevant to the discipline along with an understanding of their processes and limitations.

Curriculum Detail

ELEC440 Telecommunication Electronics

Timetabled work in hours per week			**No of teaching weeks**	**Total hours**	**No /Duration of exam papers**	**Max marks available from:**	
Lecturer	**Tutor**	**Practice**				**Exams**	**Course**
3	1.5	0.5	14	70	2/5 hours	100	100

Term: 6th

Hours			**Percentage content of**					
Lecturer	Lab/tut	Other	Maths	Basic Science	Engineering Science	Engineering Design and Synthesis	Complementary Studies	Computer Studies
42	7/21	0	20	10	30	30	0	10

Design Elements

% of Design Content	**Design Content in Course Work**	**Design Project**	**Design Content in Laboratories**
30%	X	0	X

Course Assessment Policy:

Course notes, tutorial notes, tips of weekly study and class news are posted on the course web according to the course progress. Assignments will be given to students according to the course progress, and, selected assignments' answers will be posted onto course web accordingly in addition to the weekly tutorial classes;

- 4 quizzes will be held and best 3 are graded;
- 3 experiments will be performed. 2 students form a group and individual reports should be submitted.
- A 2-hours mid-term exam and a 3-hours final exam will be performed respectively.