Sana'a University
Faculty of Engineering
Department: Electrical Engineering
Title of the Program: Communication Engineering and Networks

42. Course Specification of RF and Microwave Engineering

I. Course Identification and General Information:						
1.	Course Title:	RF and Microwave Engineering				
2.	Course Code & Number:	CNE324				
3.	Credit hours:	C.H.				Total C.H.
		Th.	Tu.	Pr.	Tr.	
		2	2	-	-	3
4.	Study level/ semester at which this course is offered:	4^{th} Level/ 2^{nd} Semester				
5.	Pre –requisite (if any):	Electromagnetics Field Theory 2(CNE212), Waves Propagation and Antennas (CNE322)				
6.	Co –requisite (if any):	None				
7.	Program (s) in which the course is offered:	Communication Engineering and Networks				
8.	Language of teaching the course:	English				
9.	Location of teaching the course:	Faculty of Engineering, Sana'a University				
10.	Prepared By:	Assoc. Prof. Dr. Mohammed A. Saeed Al-Mekhlafi				
11.	Date of Approval	2020				

II. Course Description:

This course introduces the basic principles of radio frequency (RF) and microwave engineering. Topics includes: RF behavior of passive components and RF models, chip components, distributed circuit elements, impedance and admittance transformation, parallel and series connections, impedance matching networks, analysis of single and multiport networks using network parameters, microwave filter design, microwave amplifier design, mixers and detectors, oscillators, power dividers, directional couplers, tuners, resonators, circulators, equalizers, phase shifters, electronic switches, and microwave systems.

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	III. Course Intended learning outcomes (CILOs) of the course	Referenced PILOs
a1	Describe the basic concepts and principles of radio frequency (RF) and microwave devices and circuits.	A1
a2	Understand the Radar Systems and Microwave Propagation	A1
b1	Evaluate the performance of an RF and microwave devices and circuits by looking at their representation by means of S-parameters.	B2
b2	Analyze a complete radio system, from the transmitter through the receiver front-end.	B3
c1	Solve real-world design-oriented practical problems.	C1
c2	Design impedance matching circuits suitable for RF & microwave applications.	C2
d1	Engage in life-long learning independently, to improve knowledge and competency.	D2

(A) Alignment Course Intended Learning Outcomes of Knowledge and Understanding to Teaching Strategies and Assessment Strategies:		
Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
a1 – Describe the basic concepts and principles of radio frequency (RF) and microwave devices and circuits.	▪ Interactive Lectures ▪ Class Discussions ▪ Problem Solving ▪ Demonstrations	▪ Assignments ▪ Quizzes ▪ Midterm Exam ▪ Final Exam
a2 – Understand the Radar Systems and Microwave Propagation	▪ Interactive Lectures ▪ Class Discussions ▪ Problem Solving ▪ Independent readings	▪ Assignments ▪ Quizzes ▪ Final Exam

(B) Alignment Course Intended Learning Outcomes of Intellectual Skills to Teaching Strategies and Assessment Strategies:		
Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies

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b1 – Evaluate the performance of an RF and microwave devices and circuits by looking at their representation by means of S-parameters.	▪ Interactive Lectures ▪ Class Discussions ▪ Problem Solving	▪ Assignments ▪ Quizzes ▪ Midterm Exam ▪ Final Exam
b2 – Analyze a complete radio system, from the transmitter through the receiver front-end.	▪ Interactive Lectures ▪ Class Discussions ▪ Problem Solving	▪ Assignments ▪ Quizzes ▪ Midterm Exam ▪ Final Exam

(C) Alignment Course Intended Learning Outcomes of Professional and Practical Skills to Teaching Strategies and Assessment Strategies:

Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
c1 – Solve real-world design-oriented practical problems.	▪ Interactive Lectures ▪ Class Discussions ▪ Problem Solving ▪ CAD Simulations ▪ Projects	▪ Assignments ▪ Quizzes ▪ Midterm Exam ▪ Final Exam ▪ Written Reports
c2 – Design impedance matching circuits suitable for RF & microwave applications.	▪ Interactive Lectures ▪ Class Discussions ▪ Computer base Learning ▪ Problem Solving ▪ Projects	▪ Assignments ▪ Quizzes ▪ Midterm Exam ▪ Final Exam ▪ Written Reports

(D) Alignment Course Intended Learning Outcomes of Transferable Skills to Teaching Strategies and Assessment Strategies:

Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
d1 - Engage in life-long learning independently, to improve knowledge and competency.	▪ Web-based Investigations ▪ Independent readings	▪ Written Reports

IV. Course Content:

A – Theoretical Aspect:

Order	Units/Topics List	Learning Outcomes	Sub Topics List	Number of Weeks	Contact Hours
1.	Introduction	a1	▪ RF & Microwave Spectrum, ▪ Typical Applications of RF and Microwave ▪ Safety Considerations	1	2
2.	Two Port RF Network Theory – Network Description	a1, b1, c1	▪ Review of Low Frequency Parameters (Impedance, Admittance, Hybrid and the Transmission ABCD Matrix) ▪ High Frequency Parameters Representation by the Scattering- Parameters (S-Parameters) Matrix ▪ Formulation of S-Parameters - Properties of S-Parameters ▪ Reciprocal and Lossless Networks ▪ Transmission Matrix ▪ RF behavior of Components (Wire, Resistor, Capacitor, and Inductor)	3	6
3.	RF Amplifiers and Impedance Matching Networks	a1, b1, c1, c2	▪ Amplifier power relations ▪ Stability Considerations ▪ Stabilization Methods ▪ Noise Figure, Constant VSWR, Broadband ▪ High Power and Multistage Amplifiers ▪ Impedance Matching Using Discrete Components ▪ Two Component Matching	3	6

			Networks ▪ Frequency Response and Quality Factor ▪ T and π Matching Networks ▪ Microstrip Line Matching Networks		
4.	Microwave Passive and Active Devices	a1, b1, c1	▪ Terminations, Attenuators ▪ Phase Shifters, Directional Couplers ▪ Hybrid Junctions ▪ Power Dividers, Circulator, Isolator ▪ Impedance Matching Devices (Tuning Screw, Stub and Quarter Wave Transformers) ▪ Crystal and Schottkey Diode ▪ Detector and Mixers ▪ PIN Diode Switch ▪ Gunn Diode Oscillator ▪ IMPATT Diode Oscillator and Amplifier ▪ Varactor Diode, Introduction to Microwave Integrated Circuit (MIC)	3	6

5.	Microwave Tubes, Filter Design, and Measurements	a1, b1, c1, d1	▪ Microwave Tubes - High Frequency Limitations ▪ Principle of Operation of: Multicavity Klystron ▪ Reflex Klystron ▪ Traveling Wave Tube and Magnetron ▪ Microwave Filter Design ▪ Microwave Measurements (Measurement of Power Wavelength, Impedance, SWR, Attenuation, Q and Phase Shift)	2	4
6.	Introduction to Microwave Systems	a2, b2, d1	▪ System Aspects of Antennas ▪ Wireless Communications ▪ Radar Systems and ▪ Microwave Propagation	2	4
Number of Weeks /and Units Per Semester				**14**	**28**

B - Tutorials Aspect:

Order	Tutorial Skills List	Number of Weeks	C.H.	CILOs
1.	Introduction • Review of Electromagnetic Theory • RF vs. Microwave • Safety Considerations	1	2	a1
2.	Two Port RF Networks • Low Frequency Parameters (Impedance ، Admittance, Hybrid and the Transmission ABCD Matrix) • High Frequency Parameters Representation by the Scattering-Parameters (S -Parameters) Matrix	3	6	a1, b1, c1

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	• Formulation of S-Parameters • Properties of S-Parameters • Reciprocal and Lossless Networks • Transmission Matrix • RF behavior of Components (Wire, Resistor, Capacitor and Inductor)			
3.	RF Amplifiers and Impedance Matching Networks • Amplifier power relations • Stability Considerations • Stabilization Methods • Noise Figure, Constant VSWR, Broadband • High Power and Multistage Amplifiers • Impedance Matching Using Discrete Components • Two Component Matching Networks • Frequency Response and Quality Factor • T and π Matching Networks • Microstrip Line Matching Networks	3	6	a1, b1, c1, c2
4.	Microwave Passive and Active Devices • Terminations, Attenuators • Phase Shifters, Directional Couplers • Hybrid Junctions • Power Dividers, Circulator,Isolator • Impedance Matching Devices (Tuning Screw, Stub and Quarter Wave Transformers) • Crystal and Schottkey Diode • Detector and Mixers • PIN Diode Switch • Gunn Diode Oscillator • IMPATT Diode Oscillator and Amplifier • Varactor Diode, Introduction to Microwave Integrated Circuit (MIC)	3	6	a1, b1, c1
5.	Microwave Tubes and Measurements • Microwave Tubes - High Frequency Limitations	3	6	a1, b1, c1, d1

	• Principle of Operation of : Multicavity Klystron • Reflex Klystron • Traveling Wave Tube and Magnetron • Microwave Filter Design • Microwave Measurements (Measurement of Power, Wavelength, Impedance, SWR, Attenuation, Q and Phase Shift)			
6.	Microwave Systems and Applications • System Aspects of Antennas • Wireless Communications • Radar Systems and Microwave Propagation	1	2	a2, b2, d1
Number of Weeks /and Units Per Semester		**14**	**28**	

V. Teaching strategies of the course:

- Interactive Lectures
- Class discussions
- Problem Solving
- Projects
- Independent readings
- Web-based Investigations
- Computer base Learning
- CAD Simulations

VI. Assignments:

No	Assignments	Aligned CILOs	Week Due	Mark
1.	Problems on two port RF networks	a1, b1, c1	4th	1.5
2.	Problems on RF amplifiers and impedance matching networks	a1, b1, c1, c2	7th	1.5
3.	Problems on microwave passive and active devices	a1, b1, c1	10th	1.5
4.	Problems on microwave tubes and measurements	a1, b1, c1, d1	13th	1.5

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5.	Problems on microwave systems and applications	a2, b2, d1	14th	1.5
	Total			**7.5**

VII. Schedule of Assessment Tasks for Students During the Semester:

No.	Assessment Method	Week Due	Mark	Proportion of Final Assessment	Aligned Course Learning Outcomes
1.	Assignments	4th, 7th, 10th, 13th, 14th	7.5	5%	a2, b1, b2, c1, c2
2.	Quizzes	5th ,11th ,14th	15	10%	a1, a2, b1, b2, c1, c2
3.	Attendance & Participation	Weekly	7.5	5%	a1, b1, c1, c2
4.	Midterm Exam	8th	30	20%	a1, b1, c1
5.	Final Exam	16th	90	60%	a1, a2, b1, b2, c1, c2
Total			**150**	**100%**	

VIII. Learning Resources:

- *Written in the following order: (Author - Year of publication – Title – Edition – Place of publication – Publisher).*

1- Required Textbook(s) (maximum two).

1. David M. Pozar, 2012, "Microwave Engineering", Fourth Edition, USA, JohnWiley & Sons, Inc.
2. Samuel Y Liao, 2006, "Microwave Devices & Circuits", Third edition, India, Prentice Hall of India.

2- Essential References.

1. Frank Gustrau, 2012, "RF and Microwave Engineering: Fundamentals of Wireless Communications", First Edition, UK, John Wiley & Sons Ltd.

3- Electronic Materials and Web Sites *etc*.

1. Goggling the Internet

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	IX. Course Policies:
1.	**Class Attendance:** - The students should have more than 75% of attendance according to rules and regulations of the faculty.
2.	**Tardy:** - The students should respect the timing of attending the lectures. They should attend within 15 minutes from starting of the lecture.
3.	**Exam Attendance/Punctuality:** - The student should attend the exam on time. The punctuality should be implemented according to rules and regulations of the faculty for mid-term exam and final exam.
4.	**Assignments & Projects:** - The assignment is given to the students after each chapter; the student has to submit all the assignments for checking on time.
5.	**Cheating:** - If any cheating occurred during the examination, the student is not allowed to continue and he has to face the examination committee for enquires.
6.	**Plagiarism:** - If one student attends the exam on another behalf; he will be dismissed from the faculty according to the policy, rules and regulations of the university.
7.	**Other policies:** - All the teaching materials should be kept out the examination hall and mobile phones are not allowed. - Mutual respect should be maintained between the student and his teacher and also among students. Failing in keeping this respect is subject to the policy, rules and regulations of the university.

Reviewed By	**Vice Dean for Academic Affairs and Post Graduate Studies: Asst. Prof. Dr. Tarek A. Barakat** **President of Quality Assurance Unit: Assoc. Prof. Dr. Mohammed Algorafi** **Name of Reviewer from the Department: Asst. Prof. Dr. Mohammed Al-Suraby**
	Deputy Rector for Academic Affairs Asst. Prof. Dr. Ibrahim AlMutaa **Assoc. Prof. Dr. Ahmed Mujahed**

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