The University of Jordan
School of Engineering
Electrical Engineering Department
2nd Semester – A.Y. 2023/2024

Course: **Communication Electronics – 0943423 (3 Cr. – Core Course)**

Instructor: Prof. Mohammed Hawa
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Office Hours: will be posted soon

Platform: https://www.hawa.work/423
Moodle (https://elearning.ju.edu.jo/)

Catalog description: Overview of communication system blocks. RF oscillator types and circuits. Loop gain analysis. Negative resistance analysis. Voltage controlled Oscillators (VCO). RF active mixers. Gilbert cell. Conversion loss. Nonlinear effects. Mixers applications in modulation, demodulation and frequency conversion. Tuner and resonant circuits. RF filter design: LPF, HPF, BPF and BSF. RF power amplifiers. RLC high-frequency system model. Impedance matching and transformations. Automatic gain control (AGC) circuits. Design of Low Noise Amplifiers (LNA). RF and IF tuned amplifiers. Phase locked loop design and applications. PCB RF design. Case studies. Project on the design, implementation and testing of RF circuits.

Prerequisites by course: EE 0903362 – Digital Electronics (pre-requisite), and
EE 0953421 – Communications I (pre-requisite)

Prerequisites by topic: Students are assumed to have a background in the following topics:
- Analog and digital modulation techniques.
- Electronics, amplifiers and filters.
- Fundamentals of electromagnetics and transmission lines.

Textbook: ***Microwave and RF Design (Volume 1: Radio Systems, Volume 2: Transmission Lines, Volume 3: Networks, Volume 4: Modules, Volume 5: Amplifiers and Oscillators)*** **by Michael Steer, North Carolina State University Press, 3rd Edition, 2019.** (*https://repository.lib.ncsu.edu/handle/1840.20/36776*)

References:
- *Introduction to Wireless Communication Circuits* by Forouhar Farzaneh, Ali Fotowat, Mahmoud Kamarei, Ali Nikoofard and Mohammad Elmi, River Publishers, 2nd Edition, 2020.
- *Practical Analog and RF Electronics* by Daniel B. Talbot, CRC Press, 1st Edition, 2021.
- *Wireless Communication Electronics: Introduction to RF Circuits and Design Techniques* by Robert Sobot, Springer, 2nd Edition, 2020.
- *Design of CMOS Phase-Locked Loops: From Circuit Level to Architecture Level* by Behzad Razavi, Cambridge University Press, 1st Edition, 2020.
- *Fundamentals of Microwave and RF Design* by Michael Steer, Wiley; 3rd Edition, 2019.
- *RF Microelectronics* by Behzad Razavi, Pearson, 2nd Edition, 2011.
- *Design of Analog CMOS Integrated Circuits* by Behzad Razavi, McGraw Hill, 2nd Edition, 2016.

Schedule: **Blended** [16 Weeks, 42 lectures (50 minutes each) including exams]

Course goals: The overall objective is to introduce the student to the basics of communications electronics, including analyzing analog modulation and demodulation circuits, understanding RF electronics, and designing and simulating RF transmitter/receiver circuits.

Course learning outcomes (CLO) and relation to ABET student outcomes (SO):

	Upon successful completion of this course, a student will:	[SO]
1.	Be able to identify and analyze amplitude, frequency, and phase modulation transmitters and receivers.	[1]
2.	Understand the design of basic communications blocks (oscillators, mixers, amplifiers, detectors).	[1, 2]
3.	Become familiar with circuit analysis of the main communication blocks.	[1]
4.	Understand antenna models and antenna matching principles.	[1]
5.	Become familiar with spectrum and noise performance parameters related to communication transmitters and receivers.	[1]
6.	Be able to design and build communication hardware or perform system simulation of such hardware.	[1]
7.	Learn how to identify and provide system specifications for a communication system design.	[1, 2]

Course topics:

		Hrs
1.	Communication system blocks for analog and digital modulation techniques: Double Sideband Suppressed Carrier (DSB-SC), Single Sideband (SSB), Vestigial Sideband (VSB), Quadrature Amplitude Modulation (QAM), Amplitude Modulation (AM), Amplitude Shift Keying (ASK) and digital QAM.	**2**
2.	RF Oscillators: types, design and analysis.	**4**
3.	Mixers: coherent detection and frequency/phase errors. Gilbert Cell. Switching modulator/demodulator.	**2**
4.	Frequency conversion (heterodyning). The Superheterodyne receiver. Applications.	**2**
5.	Amplitude modulation transmitters and receivers. Big picture.	**1**
6.	Noise and noise figure. Non-linearity and distortion. Reflections and s-paramters.	**2**
7.	**Midterm Exam**.	**1**
8.	More blocks for for analog and digital modulation techniques: Frequency Modulation (FM), Phase Modulation (PM), Frequency Shift Keying (FSK), Phase Shift Keying (PSK).	**2**
9.	Frequency and Phase modulation transmitters and receivers.	**2**
10.	Voltage-controlled oscillator (VCO): types and design.	**3**
11.	Phase Locked Loops (PLL): Operation and analysis. Phase detectors. Applications. Frequency synthesizers.	**3**
12.	Antennas. Impedance matching and transformation. Transmission lines and RF PCB design consderations.	**2**
13.	Resonant and tuned circuits. Filter types and design considerations.	**2**
14.	Amplifier types and design. Power amplifiers. Power efficiency.	**2**
15.	Low noise amplifier (LNA). Cascaded amplifiers. Automatic Gain Control (AGC).	**1**
16.	**(Project)** Design, build and test communication hardware (transmitter or receiver) or perform system simulation of such hardware.	**10**

Ground rules:

Attendance is required and highly encouraged. To that end, attendance will be taken every lecture. Eating and drinking are **not** allowed during class, and cell phones must be set to silent mode. All exams (including the final exam) should be considered **cumulative**. Exams are closed book. No scratch paper is allowed. You will be held responsible for all reading material assigned, even if it is not explicitly covered in lecture notes. Academic integrity must be maintained.

Assessment & grading policy:

First Exam	**0 %**	Assignments	**0 %**
Midterm Exam	**30 %**	Projects	**30 %**
Final Exam	**40 %**	Lab Reports	**0 %**
Quizzes	**0 %**	Presentation	**0 %**
		Total	**100 %**

Last Updated:

February 2024