The University of Jordan
School of Engineering
Electrical Engineering Department
2nd Semester – A.Y. 2020/2021

Course: **Medical Electronics – 0903561 (3 Cr. – Elective Course)**

Instructor: Dr. Hani Jamleh
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Office Hours: Will be posted soon

Course website: http://elearning.ju.edu.jo/

Catalog description: Introduction to medical instrumentation. Sensors and electrodes: resistive, inductive, and capacitive sensors. Piezoelectric sensors. Thermistors. Optical measurements. Introduction to biopotential signals. Biopotential amplifiers and signal processors. Cardiovascular system instrumentation: direct and indirect blood pressure measurement. Heart-sound measurement. Blood flowmeters. Plethysmography. Respiratory system instrumentation. Introduction to medical imaging systems: radiography. Computed tomography. Ultrasonic scanning. Therapeutic and prosthetic Devices: Cardiac pacemakers. Defibrillators and cardioverters. Ventilators. Infant incubators. Drug delivery devices. Electrosurgical unit. Electrical Safety.

Prerequisites by course: **EE** **0903361** Electronics (II) (pre-requisite)

Prerequisites by topic: Students are assumed to have a background in the following topics:
- Electrical circuit analysis techniques.
- Electronics and semiconductor fundamentals.
- Solution of ordinary differential equations.

Textbook: **Medical Instrumentation: Application and Design by John G. Webster, Wiley, 4th edition, 2009.**

References:
1. Introduction to Instrumentation and Measurements by Robert B. Northrop, CRC Press, 3rd edition, 2017.
2. Analysis and Application of Analog Electronic Circuits to Biomedical Instrumentation by Robert B. Northrop, Routledge, 2nd edition, 2017.
3. Basic Electronic Troubleshooting for Biomedical Technicians by Nicholas Cram, TSTC Publishing, 2nd edition, 2010.
4. Design and Development of Medical Electronic Instrumentation: A Practical Perspective of the Design, Construction, and Test of Medical Devices by David Prutchi and Michael Norris, 1st edition, Wiley-Interscience, 2004.

5. Introduction to Biomedical Equipment Technology by Joseph J. Carr and John M. Brown, Pearson, 4th Edition, 2000.
6. Microelectronic Circuits by Adel S. Sedra and Kenneth C. Smith, Oxford University Press, 7th Edition, 2014.
7. Microelectronics Circuit Analysis and Design by Donald A Neamen, McGraw-Hill Education, 4th edition, 2009.

Schedule: 16 Weeks, 42 lectures (50 minutes each) plus exams.

Course goals: The overall objective is to introduce the student to electronic circuits, devices and instrumentation used in the biomedical area. Students will gain basic knowledge of the transducers, analog and digital instrumentation, signal acquisition and processing, and electrical safety in the medical environment. In addition, electrical properties of nerve and muscle physiology, cardiopulmonary, neurological, surgical, and rehabilitation areas of medicine are all discussed.

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 analyze and design general medical electronic circuits.	[1, 2]
2. Develop a working knowledge of medical instrumentation devices in a variety of configurations.	[1]
3. Be able to analyze and design amplifiers based on both DC and AC response of the system.	[1, 2]
4. Be able to analyze and design active filters for biomedical applications.	[1, 2]

Course topics:	**Hrs**
1. Practical Operational Amplifiers: Op-Amp Circuits. Biomedical Instrumentation Amplifier, Integrators, and Differentiators. Medical Isolation Amplifiers. Active filters and its applications. Digital interfaces in measurement systems.	**10**
2. Measurement systems: Origin of Biopotential Signals. Measurement of Electrical potentials from the Body surface Electrodes. Half-Cell Potential and its Equivalent Circuit. Noise and coherent interference in measurements. Analog signal conditioning. Biopotential amplifiers.	**10**
3. Electrical Functioning of the heart, the muscles, and the neural system. The ECG: Electrode placement, Vector cardiography, Driven-Leg ECG amplifiers, Design Example (QRS complex segmentation). The EMG. The EEG.	**16**
4. Sensors commonly encountered in biomedical applications: Temperature sensors. Automatic non-invasive blood pressure measurements. Design Example: Design of a non-invasive blood pressure measurement system. Optical sensors: Pulse Oximetry.	**6**

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.

Assessment & grading policy:

Assignments	0%	Quizzes	0%
First Exam	15%	Projects	15%
Midterm Exam	30%	Lab Reports	0%
Final Exam	40%	Presentation	0%
		Total	**100%**

Last Revised: March 2021