**Jordan University of Science and Technology**
**Faculty of Engineering**
**Biomedical Engineering Department**

# Medical Electronics I, BME 313

| Course Catalog |
|---|
| Introduction to Semiconductors, Diode types, circuits and applications, Bipolar Junction Transistors (BJT) types and biasing circuits, Field effect transistors (FET) types and biasing circuits, Small-signal BJT and FET amplifiers, Multistage amplifiers, Frequency response of amplifiers, Introduction to differential amplifiers, Medical applications of diode circuits and transistor amplifiers. |

| Text Book(s) | |
|---|---|
| **Title** | MicroElectronics Circuit Analysis and Design |
| **Author(s)** | Donald A. Neamen |
| **Publisher** | McGraw-Hill |
| **Year** | 2010 |
| **Edition** | 4th edition |

| References | |
|---|---|
| **Books** | • Electronic Circuits, Discrete and integrated, D. L. Schilling and C. Belove. McGraw-Hill.<br>• Microelectronics circuits; Adel Sedra and Kenneth Smith, Oxford Press, 1998<br>• Electronic Design, Circuits and Systems; Savant, Roden, Carpenter; IRWIN. |
| **Journals** | • IEEE Transactions on Circuits and Systems<br>• IEEE Transactions on Instrumentation and Measurements<br>• International Journal of Electronics<br>• IEEE Transactions on Biomedical Engineering<br>• American Journal of Medical Electronics<br>• Japanese Journal of Medical Electronics |
| **Internet links** | • http://www.artofelectronics.com/<br>• http://www.phys.ualberta.ca/~gingrich/phys395/notes/phys395.html<br>• http://www.allaboutcircuits.com/<br>• http://claymore.engineer.gvsu.edu/~jackh/eod/electric/ |
| **Software** | • PSpice and Orcad<br>• Electronics Work Bench |

| Instructor | |
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| **Instructor** | Eng. Razan Shatnawi |
| **Office location** | |
| **Office phone** | |
| **Office hours** | Sun, Tues, Thur $9:30_{AM}$-$11:30_{AM}$ |
| **Email** | Razan.shatnawi@outlook.com |

| Prerequisite | |
|---|---|
| **Prerequisites by topic** | Electric Circuit Analysis |
| **Prerequisites by course** | BME 212 (+ pass) |
| **Co-requisites by course** | ------ |
| **Prerequisite for** | BME 314, BME 316 |

| Evaluation | | |
|---|---|---|
| **Assessment Tool** | **Weight** | **Expected Due Date** |
| **First Exam** | 25 % | According to the department schedule |
| **Second Exam** | 25 % | According to the department schedule |
| **Home works and Performance** | 10% | |
| **Final Exam** | 40 % | According to the University final examination schedule |

| Topics covered | | |
|---|---|---|
| **Week** | **Topics** | **Chapters in Textbook** |
| **1-2** | **Introduction to Semiconductors:**<br>Semiconductor materials; Carriers, N- and P-types, Conductivity and Drift Current, P-N Junctions; Forward and Reverse Biasing. | Chapter 1 |
| **2-3** | **Diode Circuits:**<br>Large signal applications: rectification, filtering, peak detectors, clipping and clamping circuits. Small signal analysis and dynamic resistance. | Chapter 2 |
| **4-6** | **Bipolar Junction Transistor:**<br>Structure, symbol and types I-V characteristics<br>Biasing circuits and types of biasing: Common Base (CB), Common Emitter (CE), and Common Collector (CC).<br>Small signal analysis. Small signal model for CE, CB and CC amplifiers<br>Specifications of BJT amplifiers | Chapter 5 & Chapter 6 |
| **7-9** | **Field Effect Transistor:**<br>Structure, symbol and types. I-V characteristics<br>Biasing circuits of FET. Small signal analysis of FET amplifiers (Common Gate (CG), Common Source (CS), and Common Drain (CD)). Specifications of FET amplifiers | Chapter 3 & Chapter 4 |
| **10-11** | **Multistage Amplifiers:**<br>Multistage Amplifiers. Methods of coupling. RC and DC coupling. Cascade BJT, FET and BiFET amplifiers. Darlington amplifiers | Chapter 5& Chapter 6 |
| **12-14** | **Frequency Response**<br>Low and high frequency response of:<br>1. Single stage amplifiers<br>2. Multistage amplifiers | Chapter 7 |
| **15-16** | **Differential Amplifiers**<br>Basic BJT differential pair<br>Basic FET differential pair<br>Analysis of differential amplifier | Chapter 11 |

## Objective and outcomes

| Objectives | Outcomes |
|---|---|
| 1. Understand semiconductor materials and operation of semiconductor devices [1, 2, 6] | 1.1. Recognize the structure of a semiconductor material.<br>1.2. Recognize the carrier action in semiconductor material.<br>1.3. Recognize the structure and operation of a PN junction<br>1.4. Recognize the IV characteristics of a PN junction |
| 2. Analyze diode circuits (small signal and large signal applications), [1, 2, 6, 4] | 2.1 Get familiar with the large signal applications of a diode with the large signal applications of diode circuit rectifiers, clipping and clamping circuits and peak detectors.<br>2.2. Get familiar with the small signal analysis of diode circuit. |
| 3. Design and analysis of bipolar junction transistor (BJT) circuits and amplifiers [1, 2, 6, 7, 4] | 3.1. Recognize the different configurations of a BJT<br>3.2 Analyze different transistor circuits in DC and determine Q-Point.<br>3.3. Derive and produce small signal model of a BJT<br>3.4. Analyze amplifier circuits and determine gain and impedance matching |
| 4. Analysis and design of Field Effect transistor (FET) circuits and amplifiers [1, 2, 6, 4] | 4.1. Recognize the different configurations of a JFET and MOSFET<br>4.2. Analyze different transistor circuits in DC and determine Q-point<br>4.3. Able to derive and produce small signal model of a JFET and MOSFET<br>4.4. Analyze amplifier circuits and determine gain and impedance matching |
| 5. Design and Analysis of multistage circuits and amplifiers [1, 2, 4,6] | 5.1. Recognize the different methods of coupling of BJT and FET multistage amplifiers<br>5.2. Get familiar with the analysis and design of multistage amplifiers |
| 6. Study of Frequency Response of Electronic Circuits [1, 4, 6] | 6.1. Get familiar with the effect of low and high frequency on an amplifier<br>6.2. Able to determine approximate lower and upper cut-off frequencies<br>6.3. Able to determine the bandwidth of an amplifier. |
| 7. Analysis and design of differential amplifiers. [1, 2, 4, 6] | 7.1. Identify the importance of differential amplifiers<br>7.2. Recognize the different types of multistage<br>7.3. Get familiar with the analysis and design procedures of differential amplifiers |

## Policy

**Attendance:** Class attendance is required and applied according to the university regulations (Student's Guide). Data support the idea that class attendance improves learning. It is very difficult as well as uninspiring for me to help a student who does not attend lectures. What is created in the classroom cannot be reenacted. Make-up tests will be done according to the university regulations (please see student's guide)

**Homework:** Working homework problems is an essential part of this course and they represent a key opportunity to learn the subjects discussed. All homework problems assigned during a given week are due at the beginning of class on the second meeting of the following week unless otherwise stated. Late homework will not be accepted. Failure to turn in this particular homework on time will result in a grade of 0 (zero) for the homework contribution to your final grade. Team work is encouraged; however, the work one hands in must represent his/her own effort. Some homework solutions will be discussed in class. There will be no handouts of homework solutions.

**Quiz:** Short questions or one of the homework problems will be used as a quiz. This strategy is meant to measure your understanding of the previous lecture and the homework solutions, and to reinforce your ability of answering questions during exams.

**Student Conduct**: It is the responsibility of each student to adhere to the principles of academic integrity. Academic integrity means that a student is honest with him/herself, fellow students, instructors, and the University in matters concerning his or her educational endeavors. Cheating will not be tolerated in this course. University regulations will be pursued and enforced on any cheating student

## Contribution of Course to Meeting the Professional Component

The course introduces the field of biomedical engineering and provides the basic principles of ethics in the field while teaching the students the implementation of communication skills.

### Relationship to Program Outcomes (%)

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
| 80 | 7 | | | 5 | 5 | 3 | | |

### Relationship to Biomedical Engineering Program Objectives

| PEO1 | PEO2 | PEO3 | PEO 4 |
|---|---|---|---|
| √ | √ | √ | √ |

Prepared by: Eng. Razan Shatnawi
Last Modified: Jan 28, 2019