

BME 372 Biomedical Electronics



The Department of
Biomedical Engineering

CLASS HOURS

Tuesday 11:30am – 12:50pm
CKB 114
Thursday 1:00 pm – 2:20pm
Room: Fenster 640

OFFICE HOURS (Fenster 610)

F, 12:00pm – 1:00pm
Or by appointment
(973) 596 3193 joelsd@njit.edu

TEXT

Electronics, 2nd Edition, Hambley
ISBN: 0136919820

Supplemental handouts are found on <http://web.njit.edu/~joelsd>

COURSE DESCRIPTION

Prerequisite: BME 301. This is the first of a two-semester sequence. It covers the design of electronic circuits for Biomedical applications. This course covers basic operational amplifier circuits as well as the operation of semiconductor diodes and transistors. An introduction to digital logic circuits is also provided. Hands-on breadboarding of electronic circuits is used throughout the course to supplement the lectures.

LEARNING OUTCOMES

By the end of the course you should be able to do the following:

- **Fundamental Electronics:** Understand the fundamental principles electronics. In particular, gain knowledge in circuit analysis, amplifiers, operational amplifiers, diodes and transistors. Apply knowledge of engineering and science to identify, formulate, and solve problems in these areas.
- **Data Interpretation:** Learn to design, test, and analyze electronic circuits using oscilloscopes and other electronics test equipment. Apply knowledge of engineering and science to interpret data. Develop an understanding of and develop the skills necessary to communicate findings and interpretations in an effective laboratory report.
- **Electronic circuits for Biomedical Applications:** Apply knowledge of engineering and science to understand the principle of biomedical electronic circuits. Understand how to apply, measure circuit performance, and solve problems in the areas of biomedical signals.
- **Work in Multi-disciplinary teams:** Learn to work and communicate effectively with peers on multi-disciplinary teams to attain a common goal.

COURSE OUTLINE*

| Date | Topic/Lecture | | Material | Class work | Reading/Problem Assignment |
|-------------|--|-------------|-----------------|--|-----------------------------------|
| 1/21 | Electrical Basics | 1 | Handouts | In-class discussion; | See Notes |
| 1/23 | Circuit Analysis | 2 | Handouts | In-class discussion; Review exercises | See Notes |
| 1/28 | Circuit Analysis | 2 | Handouts | In-class discussion; Review exercises | See Notes |
| 1/30 | Basic Electronics | 3 | Chapter 1 | In-class discussion; Review exercises | See Notes |
| 2/4 | Op Amps | 4 | Chapter 2 | In-class discussion; Review exercises | See Notes |
| 2/6 | Arduino H/W and S/W Basics | 5/6 | Handouts | In-class discussion; Review exercises | See Notes |
| 2/11 | Arduino S/W | 7 | Handouts | Review exercises and homework | |
| 2/13 | Review | | | | |
| 2/18 | Semiconductors Diodes and BJT Transistors | 8 | | In-class discussion; Review exercises | See Notes |
| 2/20 | Exam #1 | | Handouts | In-class discussion; Review exercises | See Notes |
| 2/25 | Arduino Projects: LEDs, PWM, Potentiometer Control and Astable | Labs 1&2/4 | Handouts | In-class discussion; Review exercises | This the first land second labs |
| 2/27 | Electronic Projects | Lab Op Amps | Chapter 3/4 | In-class discussion; Review exercises | This is the third lab |
| 3/4 | Semiconductors Diodes and BJT Transistors | 8 | Chapter 3/4 | In-class discussion; Review exercises | See Notes |

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|--------------|---|-------------|-----------|--|---------------------------------|
| 3/6 | FETs | 9 | Chapter 5 | In-class discussion; Review exercises | See Notes |
| 3/11 | Arduino Projects: Calculation of a capacitor and LCD | 3 | | Review exercises and homework | This is the forth lab |
| 3/13 | RC Filters | RC Filters | | | This is the fifth lab |
| Spring Break | | | | | |
| 3/25 | Feedback | 10 | Chapter 9 | Learning the Oscilloscope | |
| 3/27 | Oscillators | 11 | Chapter 9 | In-class discussion; Review exercises | |
| 4/1 | Review | | | In-class discussion; Review exercises | See Notes |
| 4/3 | Exam #2 | | | Learning the Oscilloscope | |
| 4/8 | Schmitt Triggers and 555 timers | 12 | Chapter 4 | In-class discussion; Review exercises | See Notes |
| 4/10 | Schmitt Triggers and 555 timers | 12 | | Review exercises and homework | |
| 4/15 | Electronics Projects | Wein Bridge | Chapter 4 | In-class discussion; Review exercises | This is the sixth lab |
| 4/17 | Programming/Motor Principles | 14/15 | Handouts | Real world measurement of Biomedical Signals | See Notes |
| 4/22 | Homework Review | | | Review exercises and homework | |
| 4/24 | Exam #3 | | | In-class discussion; Review exercises | |
| 4/29 | Projects DC and Servo Motors | 5/6 | | | This is the 7 th lab |
| 5/1 | 555 Timer and Arduino Plotting | 555 Timer | Handout | | |
| 5/6 | Thursday Schedule Review | | | Review exercises and homework | |

***The Course Outline may be modified at the discretion of the instructor or in the event of extenuating circumstances. Students will be notified in class of any changes to the Course outline and schedule of laboratory sessions.**

GRADING

Homework and Matlab Programming: 10%

Class attendance/participation and Laboratory Exercises (including Lab reports): 15%

Exam 1: 15%

Exam 2: 15%

Exam 3: 15%

Final Exam 30%

Attendance is mandatory. Failure to attend class regularly will result in a failing grade. No makeup examinations will be administered. If a valid, documented excuse for a missed exam is provided, the weight of the Final Exam will increase to compensate for the missed grade.

LABORATORY EXERCISES

BME 310 uses a laboratory exercises to supplement to the conventional lecture and recitation format. In general, each session will begin with a mini-lecture, followed by the laboratory exercise. These exercises are challenge-driven and require that you are fully engaged in the learning process. The laboratory exercise will be team oriented (maximum of 3 people per team) and the team will be responsible for maintaining a laboratory notebook. Each of the team members will be expected to design the initial solution, laboratory exercise coordinator (the person who coordinates the team for the laboratory exercise), take measurements, interpret the data, validate the results, and write the lab report in the laboratory notebook. The responsibilities of the team members will be different for each exercise, e.g., each team member must have the opportunity to write the lab report, to construct the initial design, etc.

Guidelines for Laboratory Reports

Your team is expected to maintain a laboratory notebook which will track the progress of each laboratory exercise. For each laboratory exercise, the lab notebook must contain

1. (prior to class) the lab exercise
2. (prior to class) a solution to the problem posed (e.g., the design of your circuit in terms of a block diagram),
3. (in class) the working circuit (circuit diagrams) and collect results (e.g., oscilloscope screens demonstrating that the circuit works),
4. interpretation and validation that the results are correct using the material discussed in class,
5. what was learned in the exercise (e.g., use of circuit design and operation, measurement equipment, troubleshooting, etc.)

6. note the team members and their responsibilities:
 - a. initial solution designer
 - b. laboratory coordinator
 - c. measurement taker
 - d. data interpreter
 - e. results validation person
 - f. lab report writer

Written lab reports must be submitted one-week after the laboratory exercise, unless otherwise specified[#]. Please note: *reports that are submitted without evidence of participation in the laboratory exercise will be considered plagiarism* and will result in dismissal from the course. You cannot copy the experimental results of others and claim credit.

Honor Code Violations/Disruptive Behavior:

NJIT has a zero-tolerance policy regarding cheating of any kind and student behavior that is disruptive to a learning environment. Any incidents will be immediately reported to the Dean of Students. In the cases the Honor Code violations are detected, the punishments range from a minimum of failure in the course plus disciplinary probation up to expulsion from NJIT with notations on students' permanent record. Avoid situations where honorable behavior could be misinterpreted.

No eating or drinking is allowed at the lectures, recitations, workshops, and laboratories. Cellular phones must be turned off during the class hours.

BME 372: Learning Outcome Summary

| Performance Criteria | Specific Activity During the Course | Assessment Methods/Metrics |
|---|--|-----------------------------------|
| Course Objective 1: Fundamental Electronics: Electronics: Using an understanding the fundamental principles electronics to gain knowledge in more complicated circuit designs, field effect transistors, amplifiers, frequency response, signal generation, timers, and wave-shaping circuits. Apply knowledge of engineering and science to identify, formulate, and solve problems in these areas. | | |
| A-1 Apply foundations of math, science, engineering to develop solution to problem | Apply student knowledge of the course materials | Final Exams |
| Course Objective 2: Data Interpretation: Learn to design, test, and analyze electronic circuits using oscilloscopes and other electronics test equipment. Apply knowledge of engineering and science to interpret data. Develop an understanding of and develop the skills necessary to communicate findings and interpretations in an effective laboratory report. | | |
| B-1 Design and conduct experiments | Designing a Transistor Amplifier. | Laboratory reports |
| B-2 Properly collect, analyze, & present data | Oscilloscope Measurements. | Laboratory reports |
| B-3 Interpret meanings from analyzed data | Oscilloscope Measurements. | Laboratory reports |
| Course Objective 3: Electronic circuits for Biomedical Applications: Apply knowledge of engineering and science to understand the principle of biomedical electronic circuits. Understand how to apply, measure circuit performance, and solve problems in the areas of biomedical signals. | | |
| E-1 Formulate a potential engineering approach | Calculation of Circuit Operation | Exams |
| E-2 Develop suitable solution to engineering problem | Calculation of Circuit Operation | Exams |
| K-2 Use Modern technology/instrumentation | Using Laboratory Test Equipment: Oscilloscopes, meters and signal generators | Laboratory reports |
| Course Objective 4: Work in Multi-disciplinary teams: Learn to work and communicate effectively with peers on multi-disciplinary teams to attain a common goal. | | |
| D-1 Work with others & share responsibilities | All laboratory experiments | Laboratory reports |
| D-2 Build consensus and effective team interactions | All laboratory experiments | Laboratory reports |

ABET Outcomes expected of graduates of BME BS program by the time that they graduate:

- (A) an ability to apply knowledge of mathematics, science, and engineering
- (B) an ability to design and conduct experiments, as well as to analyze and interpret data
- (C) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
- (D) an ability to function on multi-disciplinary teams
- (E) an ability to identify, formulate, and solve engineering problems
- (F) an understanding of professional and ethical responsibility
- (G) an ability to communicate effectively
- (H) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
- (I) a recognition of the need for, and an ability to engage in life-long learning
- (J) a knowledge of contemporary issues
- (K) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.
- (L) an understanding of biology and physiology
- (M) the capability to apply advanced mathematics (including differential equations and statistics), science, and engineering to solve problems at the interface of engineering and biology
- (N) an ability to make measurements on and interpret data from living systems
- (O) an ability to address problems associated with the interaction between living and non-living materials and systems