Dr. J Schesser Spring 2023

BME 372
Biomedical Electronics

The Department of Biomedical Engineering

CLASS HOURS
Tuesday 11:30am – 12:50pm
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
1/17	Electrical Basics	1	Handouts	In-class discussion;	See Notes
1/19	Circuit Analysis	2	Handouts	In-class discussion; Review exercises	See Notes
1/24	Circuit Analysis	2	Handouts	In-class discussion; Review exercises	See Notes
1/26	Basic Electronics	3	Chapter 1	In-class discussion; Review exercises	See Notes
1/31	Op Amps	4	Chapter 2	In-class discussion; Review exercises	See Notes
2/2	Arduino H/W and S/W Basics	5/6	Handouts	In-class discussion; Review exercises	See Notes
2/7	Arduino S/W	7	Handouts	Review exercises and homework	
2/9	Review				
2/14	Exam #1			In-class discussion; Review exercises	See Notes
2/16	Arduino Projects: LEDs, PWM, Potentiometer Control and Astable	2/3/4	Handouts	In-class discussion; Review exercises	See Notes
2/21	Electronic Projects:	Op Amps	Handouts	In-class discussion; Review exercises	See Notes
2/23	Semiconductors Diodes and BJT Transistors	8	Chapter 3/4	In-class discussion; Review exercises	See Notes
2/28	Semiconductors Diodes and BJT Transistors	8	Chapter 3/4	In-class discussion; Review exercises	See Notes
3/2	FETs	9	Chapter 5	In-class discussion; Review exercises	See Notes

3/7	Arduino Projects: Motor Control	5		Review exercises and homework	
3/9	Calculation of a capacitor and LCD	RC Filters			
Spring Break					
3/21	Feedback	10	Chapter 9	Learning the Oscilloscope	
3/23	Oscillators	11	Chapter 9	In-class discussion; Review exercises	
3/28	Review			In-class discussion; Review exercises	See Notes
3/30	Exam #2			Learning the Oscilloscope	
4/4	Schmitt Triggers and 555 timers	12	Chapter 4	In-class discussion; Review exercises	See Notes
4/6	Schmitt Triggers and 555 timers	12		Review exercises and homework	
4/11	Electronics Projects	Wein Bridge	Chapter 4	In-class discussion; Review exercises	See Notes
4/12	Programming/Motor Principles	14/15	Handouts	Real world measurement of Biomedical Signals	See Notes
4/18	Homework Review			Review exercises and homework	
4/20	Exam #3			In-class discussion; Review exercises	
4/25	Projects DC and Servo Motors	555 Timer and Arduino Plotting	Handout	Transistor Amplifier Design	
4/27	Review			Review exercises and homework	
TBD	Final Exam				

***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 form 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