BME 489
Medical Instrumentation

The Department of Biomedical Engineering

CLASS HOURS
Monday 1:00 to 2:25 (Fenster 640)
Thursday 2:30 to 3:55 (Fenster 640)

OFFICE HOURS (Fenster 611)
Monday 2:30 to 3:55
or by appointment (973) 596-5272
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TEXT
Introduction to Biomedical Equipment Technology 4th Edition by Joseph Carr and John Brown
ISBN: 0130104922
Supplemental handouts will be provided as needed.
Course Material: available at http://web.njit.edu/~alvarez/classes.htm

COURSE DESCRIPTION
Prerequisites: BME 373, BME 310 and ECE 251. The hardware and instrumentation needed to measure variables from different physiological systems. Electrodes, sensors and transducers. Bioelectric amplifiers. Hardware for measurement of the ECG, EEG, EMG, respiratory system, nervous system . Clinical laboratory instruments. Medical ultrasound. Electrical safety. Computers in biomedical instrumentation.

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

1. **Biomedical Signals and Instrumentation Sensors**: Learn several signals that can be measured from the human body. Specific examples include temperature, electrical, and pressure signals. Understand how noise from the environment, instruments and other physiologic systems can create artifacts in instrumentation. Understand the theory of how several sensors operate and use these sensors in laboratory sessions. Specific examples include thermistors and electrodes.

2. **Instrumentation Design:** Understand theory and design on Wheatstone bridge; inverting, noninverting, differential and instrumentation amplifiers. Design filters necessary to condition and isolate a signal. Understand how signals are digitized and stored in a computer or presented on an output display.

3. **Instrumentation Application:** Review the cardiac, respiratory and neural physiological systems. Study the designs of several instruments used to acquire signals from living systems. Examples of instruments studied include ECG, blood pressure monitors, spirometers, EEG, MRI, and ultrasound. Integrate information learned about biomedical signals, sensors and instrumentation design to create a design of your own.

4. **Work in Multi-disciplinary Teams:** Learn written and oral communication skills necessary to present information learned from laboratory sessions. Learn how to work in a group to attain a common goal.

COURSE OUTLINE*

Class	Date	Reading	Subject	Homework & Report Due Dates
Class 1	9/6	3 & 4	Decibels and Basic Theories of Measurement	Ch3 Prob 16,17,21 Ch4 Ques & Prob 5, 18, 19, 21,22
Class 2	9/10	5	Signals and Noise	Ch5 Prob 4, 6, 7, 8, 10, 11, 12, 13
Class 3,4	9/13 & 9/17	6	Electrodes, Sensors and Transducers	Ch6 Prob 1, 3 to 6, 9
Class 5	9/20	7	Bioelectric Amplifiers	
Class 6	9/24	6	Wheatstone Bridge Lab Exercise 1	Assign Lab Report
Class 7	9/27	7	Bioelectric Amplifiers	Ch 7: Problems 1-10
Class 8	10/1	7	Inverting Amplifier Lab Exercise 2	**Lab 1 Due**
Class 9	10/4	7	In class problem solving session & Review	
Class 10	10/8		Filter Lab Exercise 3	**Lab 2 Due**
Class 11	10/11		Review	
Class 12	10/15	3-7	Exam 1	
Class 13	10/18	2	Heart and Circulatory System	**Lab 3 Due** Ch 2 Ques 1-39 (single word answers)Ch 2 Prob 1, 3, 7, 12, 14, 17
Class 14	10/22	8	Electrocardiographs	Ch 8 prob 1 & other problems assigned at end of lecture
Class 15 & 16	10/25 & 10/29		ECG lab 3	
Class 17 &18	11/1 &11/5	9	Physiological Pressure and other Cardiovascular Measurements and Devices	Ch 9 Prob 1, 3, 5 – 8, 10, 12, 15, 16
Class 19	11/8		Sphygmomanometer & FDA Lab Exercise 4	**Lab 4 Due**
Class 20	11/12		Design Lab 6	
Class 21	11/15	10	Human Respiratory System and Its Measurement	**Lab 5 Due** Ch 10 Prob 1 to 7
Class 21	11/19		Review	
Class 22	11/22	2,8,9	Exam 2	
Class 23	11/26	11	Respiratory Therapy Equipment	
Class 24	11/27	12	Human Nervous System	
Class 25 &26	11/29	13	Instrumentation for Measurement of Brain Function (EEG and MRI)	Ch 12 Prob 1 & 2
Class 27	12/1		Presentation of Lab 6	
Class 28 &29	12/4 12/8	17	Ultrasound or review	

***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 studio/ laboratory sessions.**

Grading:

Item	Percentage of Grade
Exam 1	25%
Exam 2	25%
Exam 3 (Final)	30%
Laboratory Reports and Participation	15%
Homework	5%
Total	100%

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.

Assignments: You are responsible for all weekly reading, homework assignments and laboratory experiments. The reading should be completed BEFORE class each week. Homework and Laboratory Reports are due one week after the assignment. All assignments, homework, laboratory reports, and exams must be completed by due date. There are no late exams and any homework or reports handed in late will receive a zero.

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 489: Learning Outcome Summary

Objective / Outcome 1: Students will have the ability to analyze biomedical signals, understand the theory of sensors, integrate sensors in the design of biomedical instrumentation		
Strategies & Actions (how the objective is attained in course)	Program Outcomes	Assessment Method
Lectures teach the theory of biomedical signals through derivation and application. Laboratory 1 uses a thermistor which is used to measure internal body temperature. Laboratory 5 uses electrodes to monitor ECG	A, B, C, D, E, G, K, L	Exams, Laboratory Reports, and Homework
Objective / Outcome 2: Students will have the ability to design instruments		
Strategies & Actions (how the objective is attained in course)	Program Outcomes	Assessment Method
Lectures teach the fundamental theory of amplifiers wheatstone bridges. Homework assignment give students ability to solve and design for components to be used in gain amplifiers, filter amplifiers and wheatstone bridge. Laboratories 1 through 5 give students hands-on experience in design	A, B, C, D, E, G, K	Exams, Laboratory Reports, and Homework
Objective/ Outcome 3: Students understand the application of instrumentation		
Strategies & Actions (how the objective is attained in course)	Program Outcomes	Assessment Method
Lectures will study designs and instruments that currently study biomedical signals specifically instruments used to study the cardiovascular, respiratory and neural physiologic systems, Laboratory on FDA regulations	A, E, F, J	Class discussions, Exams, Laboratory Reports and Homeworks
Objective / Outcome 4: Work in Multi- Disciplinary Teams		
Strategies & Actions (how the objective is attained in course)	Program Outcomes	Assessment Method
6 Laboratory Sessions will be used to study and design biomedical signals, sensors, instrumentation and their application.	B, C, D, E, G, K	Laboratory Reports and Final Lab Presentation

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