The University of Vermont
BIOMEDICAL ENGINEERING

BME – EE 227 Biomedical Instrumentation

A. GENERAL INFORMATION

Name of the course:	Biomedical Instrumentation
Code of the course:	BME 227 – Cross listed EE 27
Academic Year:	2019 – 2020
Semester:	Spring Semester
Student Standing:	Junior – Senior - Graduate
College of:	Engineering and Mathematical Sciences (CEMS)
Department:	Electrical and Biomedical Engineering
Credits:	3
Pre-requisites:	EE 100 or EE 004

Lecture:	Monday – Wednesday – Friday 9.40 – 10.30 (50 min) Lafayette Hall L300
Instructor:	Dr. Juan Jose Uriarte Office: Votey 309A E-mail: Juan.Uriarte@uvm.edu Office Hours: Monday 15.30 – 17.30 or by appointment

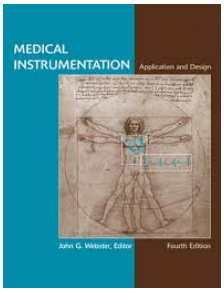
B. DESCRIPTION

Biomedical Instrumentation also known as Bioinstrumentation focuses on how medical equipment can measure physiological subject data to improve medical care. This course will provide an overview of instrumentation systems used in clinical medicine and biomedical research. We will introduce physiological signals, biomedical sensors, analog signal amplification and filters, digital acquisition, digital filtering and processing, and an overview of several common medical instrumentation platforms.

Topics presented by the instructor and invited speakers include some circuit theory, and its application to bioinstrumentation. Systems for measuring biologic signals will be discussed including biopotentials, stress and strain, pressure, temperature, and optical properties. In addition, Electrical hazards, safety, measuring instruments and techniques will be discussed.

There will also be discussion of ethical and regulatory issues related to bioinstrumentation.

C. REQUIRED TEXTBOOK



"Medical Instrumentation" Application and Design. Fourth Edition. John G. Webster. John Wiley & Sons, Inc.

Additional lists of relevant reference texts, library resources and freely accessible Internet sites will be provided. Additional course materials will also consist of research articles and other readings posted on the UVM Blackboard site.

D. LEARNING OUTCOMES and OBJECTIVES

After completing this course students will be able to:

Table 1. Course learning objectives and their relationship with ABET outcomes and class assessment tools.

#	Course Learning Objective	Associated ABET Outcome	Assessment
1	*Understand the development of biomedical instrumentation and systems based on the application of engineering disciplines to medicine*	2	E1 FP
2	*Understand the major design considerations in biomedical instrumentation*	B2	A1 A2
3	*Quantify key characteristics of biological signals processing including basic data analysis tasks (i.e. filtering, amplifying, summarizing, visualizing)*	B3	PP E2
4	*Demonstrate the ability to use the knowledge on biomedical instrumentation and measurement equipment for obtaining valid data.*	2, 5 B3, B4	A1 FP
5	*Know the role of the biomedical engineer in society. Including responsibility for protecting, specifically, patient safety, and, generally, the broader public interest.*	4	A2 FP
6	*Demonstrate the ability to source and use technical information related to biomedical instrumentation.*	7	A1 A2 Es

E=Exam; A=Assignment; FP=Final Project, PP=Project Phase

Table 2. ABET learning outcomes:

0 - little or no contribution, 1 - moderate contribution, 2 - high level of contribution

Outcome	Description	Contribution
Outcome 1	*An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.*	0
Outcome 2	*An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.*	2
Outcome 3	*An ability to communicate effectively with a range of audiences.*	0
Outcome 4	*An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.*	2
Outcome 5	*An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.*	2
Outcome 6	*An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.*	0
Outcome 7	*An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.*	2
Outcome B1	*Applying principles of engineering, biology, human physiology, chemistry, calculus-based physics, mathematics (through differential equations) and statistics.*	0
Outcome B2	*Solving bio/biomedical engineering problems, including those associated with the interaction between living and non-living systems.*	2
Outcome B3	*Analyzing, modeling, designing, and realizing bio/biomedical engineering devices, systems, components, or processes.*	2
Outcome B4	*Making measurements on and interpreting data from living systems.*	2

E. METHODOLGY

As part of learning in this course, students are expected to act as an active member of the scientific community, who will plan, prepare and develop a detailed experimental plan, to investigate in the three biomedical engineering specializations areas at UVM.

Course topics will be covered by lectures, tutorials, practical classes, and a team-based experimental approaches while students are expected to read, ask questions, participate, perform background research, and keep up with the class.

UNIT 1: Concepts of Medical Instrumentation – Chapter 1 (All Sections)
UNIT 2: Sensor and Transducers Principles – Chapter 2 (Sections 2.1 to 2.9) and Chapter 10 (Sections 10.1 to 10.2, 10.6-10.9)
UNIT 3: Amplifiers and Signal Processing – Chapter 3 (All Section)
UNIT 4: Physiology, Electric Biopotentials and Electrodes – Chapter 4, Chapter 5 and Chapter 6 (All Sections)
UNIT 5: Applications and Measurements of EKG, Respiratory System. Chapter 7 (Sections 7.1, 7.9 and 7.13), Chapter 8 (Sections 8.3 to 8.7), Chapter 9 (Sections 9.1 to 9.6), Chapter 11 (All Sections)
UNIT 6: Electrical Safety – Chapter 14 (Sections 14.1to 14.9)

F. SCHEDULE AND ASSIGNMENTS

The following course schedule is anticipated, but some adjustments may be made as the course progresses.

Dates			Topics and Activities	Assignment Due	Grading (Points)	
Week	**From**	**To**			**UG**	**GR***
1	13-Jan	17-Jan	Concepts of Medical Instrumentation			
2	20-Jan	24-Jan				
3	27-Jan	31-Jan	Sensor and Transducers			
4	3-Feb	7-Feb		Learning Package* (F)		10
5	10-Feb	14-Feb	Amplifiers and Signal Conditioning	A1 - Sensors Tutorial Paper (F)	10	5
6	17-Feb	21-Feb		A1 Oral Presentation (M-W)		
7	24-Feb	28-Feb		Exam 1 (M)	10	10
8	2-Mar	6-Mar	Filtering and Signal Processing	Project Phase I - Amplification (F)	10	10
9	9-Mar	13-Mar	C: No Class - Spring Recess			
10	16-Mar	20-Mar	Biopotentials			
11	23-Mar	27-Mar		Topic Oral Presentation* (F)		10
12	30-Mar	3-Apr	Applications and Measurements	Project Phase II - Filtering (F)	10	10
13	6-Apr	10-Apr		Exam 2 (M)	10	10
14	13-Apr	17-Apr	Electrical Safety	A2 - Medical Equipment Tutorial Paper (F)	10	10
15	20-Apr	24-Apr	Presentations	A2 Oral Presentation		
16	27-Apr	1-May		Final Project Presentation & Demo	10	10
17	4-May	8-May	**Finals Week**	**Final Exam**	20	15
				Attendance/Participation	10	
				Total Points	**100**	**100**

Legend: UG=undergraduate students, GR=graduate students, *=activity for graduate students, M=Monday, W=Wednesday and F=Friday

G. GRADING SYSTEM

The final grade for the course will be determined by the distribution of 100 points:

Undergraduate students grading system

Assignments	20%	20 points
Exam 1	10%	10 points
Exam 2	10%	10 points
Final Exam	20%	20 points
Project	30%	30 points
Att/Participation	10%	10 points

Graduate students grading system

Assignments	15%	15 points
Exam 1	10%	10 points
Exam 2	10%	10 points
Final Exam	15%	15 points
Project	30%	30 points
Learning Pack	10%	10 points
Topic Lecture	10%	10 points

The points earn directly determines your letter grade; there will be no rounding!

Score Higher Than	93	90	87	83	80	77	73	70	60	< 60
Grade	A	A-	B+	B	B-	C+	C	C-	D	F

***IMPORTANT:** Note that graduate students may be assigned an F for grades that are below 70.

H. ATTENDANCE AND PARTICIPATION

- Students are expected to read materials provided prior to class, attend, and be attentive.
- Class attendance will be checked regularly.
- Student must be in the audience for all of the projects/presentations. Failure to do so will result in reduction on his/her project/presentation grades.
- Late work will not be accepted without a legitimate excuse or illness. Written proof may be required.

I. COURTESY REMINDERS

The classroom is a learning environment. Please avoid distractions for yourself and others.

- Please turn off your cell phone during class. Do not keep your phone on your desk.
- No food is allowed in the classroom.
- Drinks are allowed, but they must have secure lids.
- Please come to class clean and free of odors and dress in a way that is appropriate for all class activities and is respectful, non-distracting and non-offensive to others.

J. INCLUSIVE LEARNING ENVIRONMENT

This classroom is a place where you will be treated with respect. I welcome individuals of all ages, backgrounds, beliefs, ethnicities, genders, gender identities, gender expressions, national origins, religious affiliations, sexual orientations, ability – and other visible and nonvisible differences. All members of this class are expected to contribute to a respectful, welcoming and inclusive environment for every other member of the class.

K. COURSE EVALUATION

All students are expected to complete an evaluation of the course at its conclusion. The evaluations will be anonymous and confidential, and the information gained, including constructive criticisms, will be used to improve the course.

L. ADDITIONAL INFORMATION

Please refer to the **ADDITIONAL INFORMATION APPENDIX**, where you can find more information about, Student Learning Accommodations, Religious Holidays, Attendance, Academic Integrity, Grade Appeals, Code of Student Conduct, FERPA Right Disclosure, Health and Safety at UVM and in keeping with University Policies.