BE 3600 BIOMEDICAL INSTRUMENTATION Spring 2003

http://www.biomed.mtu.edu/osoykan/classes/be3600/be3600.htm

3 Semester Credits

Prerequisite: EE-3010

Will meet on Tuesdays and Thursdays, 8:05 - 8:55

Classroom: ME-EM 303

Instructors:

Michael R. Neuman and Orhan Soykan
(MNeuman @ Memphis.Edu) (OSoykan @ MTU.Edu)

Teaching Assistants:

Heidi M. Niska (HMNiska @ MTU.Edu), Office Hours: to be announced

Ming Ling (MLing @ MTU.Edu), Office Hours: to be announced

Amy Latimer (ANLatime @ MTU.Edu), Office Hours: to be announced

Grading:

Midterm Exam 1 = 17.5 points
Midterm Exam 2 = 17.5 points
Comprehensive Final = 22 points
Lab Grade = 33 points
Graded Homework = 10 points
TOTAL = 100 points

A  90-100
AB  85-89
B  80-84
BC  75-79
C  70-74
CD  65-69
D  60-64
F  0-59

Tentative Syllabus is as follows:

14 January 2003, Tuesday, Introduction to the course by Michael R. Neuman
Generalized medical instrumentation system
Lecture 1
Characterizing medical instruments
Terminology
ASSIGNED READING: Notes handed out in class

16 January 2003, Thursday, Measurement systems by Heidi M. Niska
Signals and noise
Lecture 2
Electric circuits review
ASSIGNED READING: Chapter 1, pp. 1-26
21 January 2003, Tuesday, Measurement Devices
Lecture 3
Displacement transducers,
Ohmmeters and bridge circuits.
ASSIGNED READING: Chapter 2, pp.44-72

23 January 2003, Thursday, Measurement Devices,
Lecture 4
Measurement of temperature,
Potentiometer circuits.
ASSIGNED READING: Chapter 2, pp.44-72; Class Notes

28 January 2003, Tuesday, Use of Statistical Methods for Measurements,
Statistics and Instruments,
Lecture 5
Statistical processing of signals.
ASSIGNED READING: Chapter 1, pp. 26-35; Class Notes

30 January 2003, Thursday, Principles of Signals,
Fundamentals of time and frequency domain analysis,
Lecture 6
Analog and digital signals, and converters.
ASSIGNED READING: Chapter 1, pp. 26-35

4 February 2003, Tuesday, Data processing systems
Data acquisition and storage systems,
Lecture 7
Recording and display systems.
ASSIGNED READING: Chapter 7, pp. 287-308

6 February 2003, Thursday, Mechanical measurements
Measurement of force,
Lecture 8
Pressure transducers
Direct measurement of blood pressure.
ASSIGNED READING: Chapter 7, pp. 308-328

11 February 2003, Tuesday, Mechanical measurements, continued
Indirect measurement of blood pressure
Lecture 9
Sensing heart sounds
Measurement of flow
Thermal flow measurement
ASSIGNED READING: Chapter 8, pp.332-355

12-14 February 2003, Winter Carnival

18 February 2003, Tuesday, Measurement of volume and flow
Electromagnetic flow sensors
Lecture 10
Doppler flow measurement
Plethysmography
ASSIGNED READING: Chapter 8, pp.355-368

20 February 2003, Thursday, MIDTERM EXAM I (Lectures 1-9 through blood pressure)
25 February 2003, Tuesday, Electrical impedance of biologic tissue

Lecture 11
- Review of concept of electrical impedance
- Impedance bridge circuits
- Determining biological events by electrical impedance
- Detection of venous occlusion

ASSIGNED READING: Review impedance in circuits book
Chapter 4, pp. 121-125, 138-146, 164-171;

27 February 2003, Thursday, Measurement of biopotentials

Lecture 12
- Review of physics of electric fields
- Biological origin of electrical potentials,
- Electrochemical electrodes,

ASSIGNED READING: Chapter 5, pp. 183-211

3-7 March 2003 (Spring Break)

11 March 2003, Tuesday, Measurement of biopotentials, continued

Lecture 13
- Biopotential electrodes,
- Microelectrodes.

ASSIGNED READING: Chapter 5, pp. 211-226

13 March 2003, Thursday, Biopotential amplifiers

Lecture 14
- Examples of biopotential electrodes and signals,
- Review of operational amplifier circuits.

ASSIGNED READING: Chapter 3, pp. 89-115

18 March 2003, Tuesday, More biopotential amplifiers

Lecture 15
- The instrumentation amplifier,
- The electrocardiograph,
- The electromyograph.

ASSIGNED READING: Chapter 4, pp.146-151
Chapter 6, pp. 233-250

20 March 2003, Thursday, Still more biopotential amplifiers

Lecture 16
- Noise and interference in biopotential measurement,
- Cardiotachometers.

ASSIGNED READING: Chapter 6, 250-266

25 March 2003, Tuesday, Biomedical signal processing

Lecture 17
- Filtering,
- Averaging.
- Integrating.

ASSIGNED READING: Chapter 6, 267-281

27 March 2003, Thursday, Optical sensing

Lecture 18
- Review of physics of light,
- Light detecting devices,
- Elementary biomedical applications

ASSIGNED READING: Chapter 2, pp. 72-85
1 April 2003, Tuesday, Electrochemical sensors
Lecture 19
Nernst equation,
Potentiometric sensors,
Measurement of pH
Measurement of CO₂
ASSIGNED READING: Chapter 10, pp. 440-450

3 April 2003, Thursday, More electrochemical sensors
Lecture 20
Amperometric sensors
Measurement of oxygen.
ASSIGNED READING: Chapter 10, pp. 450-476

8 April 2003, Tuesday, Clinical lab instrumentation
Lecture 21
Blood gas measurement,
Bioanalytical sensors.
Glucose sensors
ASSIGNED READING: Chapter 10, pp 477-482, 486-502

10 April 2003, Thursday, MIDTERM EXAM II (Lectures 10-20)

15 April 2003, Tuesday, Chemical sensors
Lecture 22
Colorimetric sensing,
The pulse oximeter.
ASSIGNED READING: Chapter 9, pp. 470-472,
Chapter 10, pp. 507-515

17 April 2003, Thursday, Measurement of pulmonary variables
Lecture 23
Measurement of lung volumes,
Measurement of air flow,
Breathing and apnea monitoring.
ASSIGNED READING: Chapter 9, pp. 390-406

22 April 2003, Tuesday, Instrumentation for biomaterials studies
Lecture 24
Tissue characterization,
viscoelastic properties.
Biocompatibility
ASSIGNED READING: To be assigned

24 April 2003, Thursday, Instrumentation in molecular biology, by Dr. Orhan Soykan
Lecture 25
DNA sequencing technologies, Molecular Diagnostics,
Polymerase chain reactors, Blotting techniques
ASSIGNED READING: To be assigned

29 April 2003, Tuesday, Instrumentation in cellular biology, by Dr. Orhan Soykan
Lecture 26
Fluorescence Assisted Cell Sorting,
Recombination techniques, Bioreactors
ASSIGNED READING: To be assigned
1 May 2003, Thursday, Instrumentation in critical care medicine
Cardiac monitoring,
Lecture 27
Neonatal intensive care
Fetal monitoring
ASSIGNED READING: To be assigned

6 May 2003, Tuesday, General course review
Lecture 28

FINAL EXAM (Comprehensive): TBD

Required Background Knowledge:
University Level Physics, Electric Circuits, Introductory Anatomy and Physiology

Required Textbook:
Medical Instrumentation: Application and Design
Edited by John G. Webster,
Price: US$103.95 at Amazon.Com