

## **BME-650: Biomedical Measurement and Instrumentation Spring 2005**

<b><u>Instructor</u></b>	Ellis Meng Department of Biomedical Engineering DRB 159 (213) 740-6952 ellis.meng@usc.edu	<b><u>TA</u></b>	Limei Cheng limeiche@usc.edu
<b><u>Office Hours</u></b>	by appointment	<b><u>Lectures</u></b>	F 2-4:50p OHE-136
		<b><u>TA Office Hours</u></b>	Th 11a-12p DRB 145

### **Course Website**

See blackboard

### **Course Description from Catalog**

Design of measurement systems and biomedical instrumentation; architecture of electronic instruments used to measure physiological parameters, analysis of major process functions integrated in these instruments. Open to M.S., Medical Device and Diagnostic Engineering and biomedical engineering Ph.D. students only.

### **Course Prerequisites**

None.

### **Prerequisite knowledge and/or Skills**

Basic knowledge of electronics, physics, and chemistry.

### **Textbook**

Medical Instrumentation: Application and Design, 3rd ed., J.G. Webster (Ed.), John Wiley & Sons, 1998.

### **Course Objectives**

This course introduces students to the design of measurement systems and biomedical instrumentation. The course provides an overview of the architecture of electronic instruments used to measure physiological parameters and an in-depth analysis of the major functions integrated in these instruments.

After completing this course, students should be able to:

- Describe the critical measures needed to evaluate biological systems
- Describe the architecture of biomedical instruments and the principle of operation of sensors commonly used for measuring physiological variables
- Analyze biomedical measurement applications in selected organ systems (neuromuscular, cardiovascular, and pulmonary) and analytical laboratory devices (blood lab. machines)

### **Class Format and Grading Policy**

There will be one lecture per week on Friday from 2-4:50pm in OHE-136.

The final grade will be based on the following:

- (1) Homework (50%)  
Homework sets will be assigned on a biweekly basis and are due at the beginning of class on the date indicated in course outline. There will be a total of 7 homework sets.
- (2) Final paper from a research project (50%)  
Students will research a particular topic in biomedical instrumentation. A paper consisting of a comprehensive review of the selected topic will be submitted at the end of the class for 50% of the final grade. Topics need to be approved by the instructor and must be unique. Research papers will be based on articles, papers, patents, and materials found on the web.

### **Homework Collaboration Policy**

Students are expected to do their own homework assignments and should completely understand everything that they submit as their own. It is anticipated and expected that students consult one another for clarification of concepts, advice, to compare homework solutions, etc. You may also use whatever materials you find on the web, in other texts, or other sources to assist in preparing your homework and final paper. However, copying homework prepared by another student and plagiarizing are strictly prohibited.

## Course Outline and Schedule

Week	Topics Covered	Reading	HW Out	HW Due
1 (1/14/05)	Course Introduction Introduction to Instrumentation Engineering Design	Ch. 1	HW 1 Final Paper	
2 (1/21/05)	Instrumentation Terminology Signals and Noise Errors	Ch. 1		
3 (1/28/05)	Electrical Safety Shock Hazards	Ch. 14	HW 2	HW 1
4 (2/4/05)	Introduction to Sensors and Transducers	Ch. 2		
5 (2/11/05)	Amplifiers Signal Processing Interference Shielding and Guarding	Ch. 3	HW 3	HW 2
6 (2/18/05)	Pressure Measurement	Ch. 7		
7 (2/25/05)	Pressure Measurement (cont.) Cardiac Measurement Applications Flow Measurement	Ch. 8	HW 4	HW 3 Paper Topic
8 (3/4/05)	Flow Measurement (cont.) Respiratory System Applications	Ch. 9		
9 (3/11/05)	Motion Measurement Force Measurement		HW 5	HW 4 References
(3/18/05)	SPRING BREAK			
10 (3/25/05)	Temperature Measurement Heat Flow Measurement Evaporation Measurement			Detailed Outline
11 (4/1/05)	Chemical Measurement Biosensors	Ch. 10	HW 6	HW 5 List of Figures
12 (4/8/05)	Chemical Biosensors	Ch. 10		Paper Draft
13 (4/15/05)	Clinical Lab Instrumentation	Ch. 11	HW 7	HW 6
14 (4/22/05)	Therapeutic and Prosthetic Devices	Ch. 13		
15 (4/29/05)	Advanced Topics New Research Areas			HW 7 Final Paper

### Recommended Classes for Further Study in Medical Instrumentation

BME 302L	Medical Electronics
BME 425	Basics of Biomedical Imaging
BME 513	Signals and System Analysis
BME 523	Measurement and Processing of Biological Systems
BME 525	Advanced Biomedical Imaging
BME 602L	Applied Electrophysiology
AME 305	Mechanical Design
AME 503	Advanced Mechanical Design

### Course Reserves

(Available for 2 hr check-out in Leavey Library)

King, P., R. C. Fries. Design of Biomedical Devices and Systems, Marcel Dekker, 2003.

Pallás-Areny, R., J. G. Webster. Sensors and Signal Conditioning, Wiley, 2000.

Togawa, T., T. Tamura, P.A. Oberg. Biomedical Transducers and Instruments, CRC Press, 1997.

Webster, J.G. Bioinstrumentation, Wiley, 2004.

### **Research Paper Guidelines**

The suggested length is 2500 words plus ~2-4 figures. You should use at least 5 references and include at least one book, one patent, one journal article, and one web site. All journal articles used to prepare the paper must be provided. See the course outline for milestone deadlines.

### **Possible Topics for Papers**

Intra-ocular pressure  
Intra-cranial pressure  
Hot-film velocity  
Laser-Doppler flowmetry  
Inductance plethysmography  
Foot force distribution  
Evaporative water loss  
Tympanometry  
Force-sensitive resistors  
Conductive polymer force sensors  
Tympanic temperature sensors  
Nonmetallic temperature sensors  
Calorimetry of human metabolism  
Infrared telemetry  
Peñás method of blood pressure measurement  
Arterial tonometry measurement of blood pressure  
Reversible-dye optical measurement of pH  
Measuring glucose through the skin using spectrophotometry  
Sleep lab instrumentation  
Arterial compliance  
Arterial pulse wave velocity  
Hot flash sensor  
Tissue temperature during ablation  
Cochlear implant  
Retinal implant  
Neural interfaces  
Photon microscopy  
Your own topic

### **Statement for Students with Disabilities**

Any student requesting academic accommodations based on a disability is required to register with Disability Services and Programs (DSP) each semester. A letter of verification for approved accommodations can be obtained from DSP. Please be sure the letter is delivered to me (or to the TA) as early in the semester as possible. DSP is located in STU 301 and is open 8:30 a.m. – 5:00 p.m., Monday through Friday. The phone number for DSP is (213) 740-0776.