Applied Electrophysiology – BME 620
Syllabus – 2006 Fall Semester

1 Basic Information

Course Name:	Applied Electrophysiology, BME 620
Units:	4
Place and time:	Discussion in OHE 136, Fridays 10:00 am - 12:30 pm (live DEN participation for BME 599)
	Labs/workshops in DRB 351, Fridays 1:30 pm - 4:30 pm
Faculty:	Gerald E. Loeb, M.D., Professor of Biomedical Engineering
	Hilton M. Kaplan, M.D., Teaching Assistant and cardiac lecturer
	Djordje Popovic, M.D., Teaching Assistant and cardiac lecturer
Guest Lectures:	James Weiland, Ph.D., visual system
	Robert Shannon, Ph.D., auditory system
	Ted Berger, Ph.D., cortical interfaces
	Nicholas A. Sachs, M.S., oculomotor function
Office:	DRB-B10, by appointment
Telephone:	(213) 821-1112
Email:	gloeb@usc.edu, hkaplan@usc.edu, popovic@usc.edu
Prerequisites:	Introductory courses in general physiology, neuroscience and electrical engineering

2 Course Goal and Learning Objectives

This course is intended to provide the theoretical basis and applied design principles for medical devices and instrumentation that interact with electrically excitable tissues of the body:

- Excitable tissues include cardiac muscle, skeletal muscle, and central and peripheral neurons involved in sensing, control of movement and control of autonomic functions.
- Instrumentation includes therapeutic devices (pacemakers, defibrillators, cochlear implants, epidural stimulators, transcutaneous electrical stimulators, functional neuromuscular stimulators) and diagnostic devices (electrocardiography, electromyography, electroencephalography and other aspects of clinical neurophysiology).

After successfully completing this course, the student should be able to:

- estimate the feasibility of recording and stimulating any electrophysiological signal from first principles of biophysics
- describe the working principles of all currently available medical devices for therapeutic modulation of neural signals
- identify technological and biological limitations in the treatment of clinical disorders of the heart, motor control and special senses
- record and analyze common electrophysiological signals, including ECG, EMG and EEG

3 Lecture Plan

Date	Readings	Lecture Topic 10:00 AM -12:30 PM (guest lecturer)*	Lab/Workshop Topic 1:30 PM -4:30 PM
Aug. 25	Kandel 7, 8, 9	Biophysics of excitable tissues	Bioradio orientation lab
Sept. 1*	posted	Electrocardiography (Kaplan, Popovic)	ECG recording lab
Sept. 8*	posted	Cardiac Pacing (Kaplan, Popovic)	ECG analysis
Sept. 15*	posted	Cardiac Defibrillation (Popovic)	**FIRST EXAM**; Cardiac stress lab
Sept. 22	Kandel 34	Muscle Function and Electromyography	EMG recording lab
Sept. 29	Kandel 36, 37, 41	Neuromuscular Electrical Stimulation	Myoelectric control
Oct. 6	Kandel 22, 23, 36, 42, 43	Proprioception, Tremor & Spasticity	Reflexes lab
Oct. 13*	Kandel 30	Hearing and Cochlear Implants (Shannon)	Acoustic signals lab
Oct. 20	Kandel 24	Pain	TENS lab
Oct. 27	Kandel 49	Autonomic Function, GI & GU	Micturition lab
Nov. 3*	Kandel 25, 26, 27	Vision (Weiland)	Visit Weiland lab, HSC
Nov. 10*	Kandel 39, 40	Oculomotor Function (Sachs)	EOG recording lab
Nov. 17	Kandel 20, 38, 46	EEG, Evoked Potentials, MEG	EEG lab
Dec. 1*	Kandel 23	Microelectrode and Cortical Interfaces (Berger)	Electrochemistry & Impedance lab
Dec. 1		**REPORTS DUE**	
Dec. 11 (08:00 am - 10:00 am)		**FINAL EXAM**	

IT IS ESSENTIAL FOR ALL STUDENTS TO READ THE BACKGROUND MATERIAL BEFORE COMING TO CLASS FOR EACH DISCUSSION. This course is taught by Socratic Method (see description appended), in which the lecturer asks leading questions to get the students to produce the material to be learned. All students are expected to be familiar with and WILL BE CALLED UPON TO PRESENT both the basic physiology and the basic electronics relevant to each topic so that the discussion can focus on the research and design problems for the clinical applications.

4 Teaching Team

Primary Instructor: Gerald E. Loeb, M.D.
Teaching Assistant and cardiac lecturer: Hilton M. Kaplan, M.D.
Teaching Assistant: Djordje Popovic, M.D..
Guest Lectures: James Weiland, Ph.D., visual system
Robert Shannon, Ph.D., auditory system
Ted Berger, Ph.D., cortical interfaces
Nicholas Sachs, M.S., oculomotor control

5 Source Material

Primary Text: ***Principles of Neuroscience*** **(all readings required)**
Kandel, Schwartz and Jessell, ed., McGraw-Hill, 4th ed., 2000.

Additional Text: ***Bioelectromagnetism - Principles & Applications of Bioelectric & Biomagnetic Fields***
Jaakko Malmivuo & Robert Plonsey, Oxford University Press, New York, 1995 (Web version)

6 Assessment

First Exam 20% – designed to calibrate your study methods

Final Exam 40% – will cover ALL material covered in all seminars

Lab Notebook – 20% (Participation in seminar discussions for BME 599 students)

Each student will keep a laboratory notebook in which he/she records experimental objectives, methods, protocols, parameters, file information and key data. Lab notebooks must be completed "in real time". They will be collected for grading at the end of each experimental session and returned at the next session for discussion. Grading will be based on the sufficiency and clarity of the recorded information to permit the experiment to be replicated.

Report – 20%

Each student will prepare a feasibility analysis for a novel electrodiagnostic or therapeutic modality of his/her choice. This must include an executive summary (1 p), a brief review of the relevant physiology and pathology (1-2 pp), the high level design of the proposed device or instrument (1-2 pp plus figures), and a prioritized summary of the major scientific and technological risks in realizing the product (1-2 pp).

7 Resources

Lecture room and teaching laboratory with LCD projection.

8 Other Readings

See webpage at http://www-classes.usc.edu/engr/bme/620/ for supplemental materials and sources.

9 Socratic Method

The **Socratic method** of inquiry, also called the *elenchos*, as well as *elenchus*, or *elench*, was introduced by Socrates in order to discover the truth. It was first described by Plato in the **Socratic Dialogues**.
The Socratic method is a *negative* method of truth-seeking, in that truth is found by steadily identifying and eliminating that which is not true. The method of Socrates is a search for the underlying assumptions, or *axioms*, which may unconsciously shape one's opinion, and to make them the subject of scrutiny, to determine their truth or falsity. The basic form is a series of questions formulated as tests of logic and fact intended to help a person or group discover the truth about some topic. A skillful teacher can actually teach students to think for themselves using this method. This is the only classic method of teaching that is known to create genuinely autonomous thinkers.
There are some crucial principles to this form of teaching:

- The teacher must set the topic of instruction, and the student must agree to this.
- The student must agree to attempt to answer questions from the teacher.
- The teacher must be willing to accept any correctly-reasoned answer. That is, the reasoning process must be considered more important than facts.
- The teacher's questions must expose errors in the students' reasoning. That is, the teacher must reason more quickly and correctly than the student, and discover errors in the students' reasoning, and then formulate a question which the students cannot answer except by a correct reasoning process. To perform this service, the teacher must be very quick-thinking about the classic errors in reasoning.
- If the teacher makes an error of logic or fact, it is acceptable for a student to correct the teacher.

It is helpful if the teacher is able to lead a group of students in a discussion. This is not always possible in situations that require the teacher to evaluate students, but it is preferable pedagogically, because it encourages the students to reason for truth rather than from authority.
More loosely, one can label any process of thorough-going questioning as an instance of the Socratic method.