

## APHY 515 Medical Physics I

### Course Description

Introduction to Medical Physics. (3) Biomechanics, statistical physics, bioelectric fields, biomagnetic fields, electricity and magnetism at the cellular level. (3 credit hours)

Prerequisite: Permission of the department chairperson or instructor.

### Course Objective

The objective of this course is to provide an understanding of how physics plays a major role in biophysical phenomena and provide practice in working out specific examples using biophysical concepts. It is also to offer the student an introduction to the development of outstanding concepts of medical physics; to develop a background sufficient to allow the student a more knowledgeable reading of current research and background to attack problems in the workplace.

### Course Rationale

The introductory course is designed for the graduate students of the biological and physical sciences, in particular those with a major or minor in the area of medical physics, bio-nanotechnology, biology, physiology and who have a sufficient mathematical and biological maturity to meet the necessary prerequisite.

### Course Content, Format, and Bibliography

#### *Content*

#### Biomechanics

- Translational and rotational equilibrium

- Hydrostatics

#### Statistical Physics

- Thermal equilibrium

- Entropy

- The laws of thermodynamics

- The Boltzmann factor and the principle of equipartition of energy

- Fick's first and second laws of diffusion

- Transport of fluid and neutral solutes through a membrane

Bioelectric fields

- Electrochemical processes in living tissues
- Hodgkin-Huxley Model of membrane
- Electric potentials of living tissues
- EEG, ECG, and EKG
- Electrical stimulation
- Nerve conduction velocity

Biomagnetic fields

- Magnetic fields associated with living tissues
- The detection of weak magnetic fields
- Magnetic simulations of living tissues
- MEG

Electricity and magnetism at the Cellular Level

- Gouy-Chapman model
- Debye-Huckel model
- Nernst-Planck equation
- Gated membrane channels
- Noise in membranes

*Format*

Course activities will center on the lectures and assigned problems. It will be expected that the student will study several references during the course. The computer-generated animations are used to introduce, motivate, and illustrate the concepts of biophysics.

This course is taught as a dual undergraduate/graduate course. Students will be required to complete activities appropriate for the level of the course in which they are enrolled. Student performance on homework, exams and/or labs will be evaluated using different standards for undergraduate and graduate students.

Lectures and problem solving.

Graduate students in the course will be assigned one or more of the following, at the instructor's discretion, commensurate with the higher requirements of the graduate component as compared with the undergraduate component:

- Extra problem assignments
- Extra or different examination requirements
- Class lecture on assigned topic
- Assigned readings\report on the literature

*Bibliography*

Intermediate Physics for Medicine and Biology 3<sup>rd</sup> edition, Russell K. Hobbie

Bioelectromagnetism, Jaakko Malmivuo and Rober Plonsey

Bioelectricity, A Quantitative Approach, 2<sup>nd</sup> edition, Robert Plonsey and Roger Barr