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-Plank 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 3rd edition, Russell K. Hobbie
Bioelectromagnetism, Jaakko Malmivuo and Rober Plonsey
Bioelectricity, A Quantitative Approach, 2nd edition, Robert Plonsey and Roger Barr