University Of California, Berkeley
Department of Mechanical Engineering

ME 290E: Topics in Biomedical Engineering (1 unit)

Heat and Mass Transport in Biomedical Engineering

Graduate Course

Syllabus

CATALOG DESCRIPTION

An introduction to the heat and mass transport processes of importance to biomedical engineering. The course will focus on mathematical modeling, medical devices and applications of heat and mass transfer processes of importance to the biomedical field. The course will focus on three ranges of temperature: a) physiological and above physiological, b) below physiological to the freezing temperature of water and c) below the freezing temperature of water.

EXPANDED DESCRIPTION

An introduction to the heat and mass transport processes of importance to biomedical engineering. The course will focus on mathematical modeling, medical devices and applications of heat and mass transfer processes of importance to the biomedical field. The course will focus on three ranges of temperature: a) physiological and above physiological, b) below physiological to the freezing temperature of water and c) below the freezing temperature of water. The applications will range from treatment of tissues with lasers and non-thermal irreversible electroporation to newborn incubator design and hypothermic surgery at low temperature to cryopreservation of biological organs. Each one unit class will deal with one of the three ranges of temperature in the order listed above, in subsequent years. The class can be retaken as if will present new updated information in cycles of three years.

COURSE PREREQUISITES

ME 40, ME 106, ME 109, (or equivalent classes)

The class will require the ability to solve differential equations through close form analytical solutions and programs such as MATLAB

TEXTBOOK(S) AND/OR OTHER REQUIRED MATERIAL

Class notes

COURSE OBJECTIVES

Give the students the ability to analyze and design medical devices and medical processes that employ heat and mass transfer. For example, the design of a tissue ablation device for treatment of cancer or the design of a cryopreservation system for stem cell preservation for transplantation.

DESIRED COURSE OUTCOMES

The student will develop the mathematical skills to formulate and solve problems of heat and mass transfer in biological applications and the design skills to develop medical devices and medical protocols involving heat and mass transfer.

TOPICS COVERED

Unit 1A: Derivation of the physiological bioheat equation, Derivation of the bioheat equation with an exterior heat source from laser, pulsed electric fields, RF electric fields, ultrasound. Applications and design of devices in the temperature range from physiological to above physiological (hyperthermia)

Unit 1B: Derivation of the bioheat equation with cooling sources; perfusion with coolants through the vasculature and modeling the physiological response at hypothermic conditions. Applications and device design for treatment of heat shock and thermal stress, hypothermic heart and brain surgery.

Unit 1C: Derivation of equations of heat transfer with phase transition to model freezing in cells and tissue. Mass transfer for introduction of cryoprotectants into biological organs and cells and for the process of freezing in solutions. Applications and device design for cryopreservation of organs and cells.

CLASS/LABORATORY SCHEDULE

3 hours lecture per week. Six weeks of lecture.

CONTRIBUTION OF THE COURSE TO MEETING THE PROFESSIONAL COMPONENT

Strong design component.

ASSESSMENT OF STUDENT PROGRESS TOWARD COURSE OBJECTIVES

A midterm to test mathematical analysis skills and a semester design project.

PERSON(S) WHO PREPARED THIS DESCRIPTION

Boris Rubinsky, August16, 2012

ABBREVIATED TRANSCRIPT TITLE (19 SPACES MAXIMUM): Topics BioMed Eng
TIE CODE: LECT
GRADING: Letter
SEMESTER OFFERED: Spring
COURSES THAT WILL RESTRICT CREDIT: none
INSTRUCTORS: Rubinsky
DURATION OF COURSE: 6 Weeks
EST. TOTAL NUMBER OF REQUIRED HRS OF STUDENT WORK PER WEEK: 6
IS COURSE REPEATABLE FOR CREDIT? yes
CROSSLIST: None