UMBC UGC New Course Request: ENME 422 Heat Transfer in Biological Systems

Date Submitted: November 2, 2009 Proposed Effective Date: Fall 2010

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COURSE INFORMATION:

Course Number(s)	ENME 422 (previously offered as ENME 489 H)
Formal Title	Heat Transfer in Biological Systems
Transcript Title (≤24c)	
Recommended Course Preparation	
Prerequisite	ENME321
Credits	3
Repeatable?	☐ Yes X No
Max. Total Credits	3
If yes, how many total credits?	
Grading Method(s)	X Reg (A-F) ☐ Audit ☐ Pass-Fail

PROPOSED CATALOG DESCRIPTION:

This is a cross-listed course offered to upper level undergraduate students as a science elective, and regular graduate students. The course focuses on how heat transfer mechanisms and principles are applied to biological systems. It includes how to model heat transfer in tissue with blood perfusion, major experimental approaches for measuring thermal and physiological properties of tissue, as well as detailed description of various aspects of bioheat transfer analyses in hyperthermia treatment to kill tumor.

RATIONALE FOR NEW COURSE:

This course is offered to provide students with training in an interdisciplinary research field.

ATTACH COURSE OUTLINE (mandatory):

Topics to be covered:

1. Early History and Current Developments in Bioheat Transfer
2. Introduction to Heat Transfer in Biological System
    - Hemodynamics of blood flow
    - Thermal regulation and blood flow
    - Fundamental concepts of bioheat transfer,
3. Bioheat transfer modeling
    - Different approaches in bioheat transfer modeling
    - Continuum model (Pennes, Weinbaum-Jiji, etc.)
    - Model validation by experiments and vascular model
    - Theoretical modeling of the whole body
4. Temperature, blood flow and thermal property measurements
    - Temperature
        - Invasive temperature sensors (thermocouples and thermistors)
        - Non-invasive temperature measuring devices (thermal image and MRI)
    - Thermal property

- Difficulties encountered for biomaterial
- Theoretical determination of thermal properties
- Experimental techniques (hot plate, flush method, needle probe, & TPD)

Blood flow

- Radio-labeled microsphere, strain gauge plethysmography, doppler ultrasound, laser Doppler flowmetry, TPD

5. Hyperthermia Treatment for tumors and cancers

Temperature monitoring during thermotherapy

Heat patterns induced by hyperthermia applicators

- Hyperthermia treatment volume and ideal temperature distribution
- Relationship between SAR (specific absorption rate) and its generated temperature field
- Currently used heating devices (high energy DC shock, RF, microwave, laser photocoagulation, & ultrasound, as well as nanoparticle hyperthermia)
- Determination of SAR

Dynamic response of blood flow to hyperthermia

Theoretical modeling the temperature distribution during hyperthermia

Assessment of thermal damage