University of Wisconsin - Madison  
College of Engineering [EGR]  
Last Offered: 2011-2012 Spring [1124]  
Direct Link to this Syllabus:  
http://aefis.wisc.edu/index.cfm/page/CourseAdmin.ViewABET?coursecatalogid=975&pdf=True

1. **E C E 461, Mathematical and Computer Modeling of Physiological Systems**
2. **Credits**: 3  
   **Contact Hours**: 2.5

   a. **Other Supplemental Materials**: None

   • **Specific Course Information**:

   a. **Brief description of the content of the course (Course Catalog Description)**:  
      Mathematical and computer modeling of physiological systems; principal emphasis on cardiovascular system and individual nerve cells; other topics include respiratory system and skeletal-muscle system; extensive use of 'hands-on' computer modeling using ACSL.

   b. **Pre-requisites or Co-requisites**: ECE 330 or cons inst

   c. **This is a Selected Elective course**.

   • **Specific Goals for the Course**:

   a. **Course Outcomes**:

      1. Bringing together knowledge in physiology and modeling techniques, this course will develop the student's ability: To appreciate the value and application of physiological models
      2. To understand the physiology of some vital organs
      3. To understand the process of modeling dynamically varying physiological systems
      4. To understand methods and techniques to analyze and synthesize dynamic models
      5. To develop differential equations to describe the dynamic behavior of physiological systems
6. To simulate and visualize dynamic responses of physiological models using computers
7. To define and implement physiological models for education, research and product development
8. To solve and implement a modeling and design problem from inception to completion

- **ABET Student Learning Outcomes:**

  (a) Ability to apply mathematics, science and engineering principles.
  (b) Ability to design and conduct experiments, analyze and interpret data.
  (c) Ability to identify, formulate and solve engineering problems.
  (d) Ability to use the techniques, skills and modern engineering tools necessary for engineering practice.

- **Brief List of Topics to be Covered:**

  - Applications of mathematical & computer physiological models Fundamental principles, processes and tools in model development
  - Analysis and synthesis of dynamic models
  - Pressure-flow Model; Cardiac and circulation dynamics; Lung mechanics;
  - Model approximation and simplification; Cardiovascular system (Lumped model; Linearization; Non-pulsatile)
  - Gas exchange and transport model; Oxygen and carbon dioxide exchange; Respiratory system
  - Compartment Model; Mass transport through diffusion and fluid flow
  - Multiple Model; Oxygen and Carbon dioxide transport, Inhaled anesthetic uptake and distribution; Renal system
  - Interactive Large-scale Multiple Model; Interaction between inhaled anesthetics and blood circulation
  - Concentration/Population Equilibrium Model; Enzyme reaction (Michaelis-Menton kinetics); Membrane resting and action potential (Nerst equation); Immune system
  - Cable conduction model; electrical conduction and Signal propagation in the nervous system
- Finite difference Model; Heat flow and thermal regulation

- Finite element Model; Cardiac Tissue

- Descriptive Quantitative Model; Body fluid balance; Glucose-Insulin regulation;

- Feedback models; Starling Law, Neural feedback (Baroreceptor loop, neuromuscular), thermal regulation

- Programming language ACSL and Matlab/Simulink/Visualization

- Survey of commercial and research in Virtual Physiological systems in medical education