**Department of Biomedical Engineering**
**BME 382 – ENGINEERING PHYSIOLOGY**

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| **COURSE INSTRUCTOR:** **Dr. Ghazaleh Khayat**<br><br>**Professional Component:** Medical / Biological Topics/ modeling | **3 credits Required CLASS HOURS 4.5 hours / week** | **OFFICE HOURS (Fenster 612) Thursday 1:00 pm Or by appointment** | **Textbook:** Fundamentals of Human Physiology, 4th Edition<br>Lauralee Sherwood - West Virginia University<br>ISBN-10: 0840062257<br>ISBN-13: 9780840062253 |

**Description:**
Students learn to develop quantitative models of organs and physiological systems. Students translate their understanding of physiological systems into models that evolve dynamically based on engineering block diagrams. Additional topics include hierarchical structure, sensitivity analysis, parameter estimation, negative feedback control, and characteristic traits of models. Students will use models to gain insight into how a physiological system functions. Systems studied include the cardiovascular system, nerve and muscle action potentials, and Musculo-skeletal spinal reflex.

**Prerequisites:** Prerequisites: BME 111, BME 301, BME 302 and MATH 222 all with a C or better.

**Objectives:** Developing quantitative models is an essential discipline needed to be learned by every engineering student.
To understand the principles of modelling physiological systems the student will:

- Understand the physiological system intended to be modeled.
- Identify which is the specific interest and future use of the model to be developed.
- Define and select the parameters and variables needed for the intended modeling.
- Develop an equivalent physical model.
- Define the equations pertinent to the model.
- Develop a computer-based model using Simulink

| Week | Course outline |
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| 1 | Introduction to Engineering Models of Physiological Systems<br>Intro to Simulink |
| 2 | Model 1 Arterial System<br>Tips on Translating Physical-to-SIMULINK Model File<br>Physical Model of Lumped Arterial System |

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| 3 | Physical Model of Lumped Arterial System |
| 4 | Model 2 Left Ventricle E(t). Top-Down Model Development |
| 5 | Model 3 Left Heart + Vasculature. Estimate Arterial Compliance |
| 6 | Model 4 Complete Circulation: LV+RV |
| 7 | Mid-Term Exam |
| 8 | Model 5 Autonomic Nervous Control of Circulation. Arterial Baroreceptors. |
| 9 | Model 5 Arterial Baroreceptors. Neg. Feedback System Analysis |
| 10 | Model 6 Neuro-Muscular Control.6 Muscle Reflex Diagram |
| 11 | Model 6 Limb Mechanics. Muscle Contraction. Spindle Sensor & Filter |
| 12 | Model 7 Neural Action Potential. Introduction To Neuron |
| 13 | Model 7 Introduction to Neuron. Neuron Subsystem Overview |
| 14 | Final Exam / (Final Project) |

**The Course Outline may be modified at the discretion of the instructor or in the event of extenuating circumstances. Students will be notified in class of any changes to the Course outline and schedule.**

**BME 3823: Course Learning Outcome**

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| **<u>OUTCOME 6:</u>**<br>**An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions** | |
| **Outcome #6. 1.** Be able to describe a major physiological system and identify their major elements and describe their relationship and performance in living organisms. | |
| **Strategies & Actions** | **Assessment Methods** |
| During the introductory sessions, students will review the pertinent physiology of the system of interest.<br>They will define the scope of the intended model and identify the basic elements of interest for the intended model. | Lab report. Class discussions. Quizzes |
| **Outcome # 6.2.** Be able to identify the elements of the physiological system and mathematically describe their interaction to achieve homeostasis**.** | |
| **Strategies & Actions** | |
| Students will create a theoretical mechanical equivalent (Physical Equivalent) of the physiological system model, consisting of different instruments or parts that will allow a better understanding of the physics to be used governing the model. From this "Physical Equivalent" of the model, the student will identify and select the mathematical expressions describing the behavior of the system. | Lab report. Class discussions. Quizzes |
| **Outcome # 6.3.** Be able to derive a computational model of the physiological system using Simulink**.** | |
| **Strategies & Actions** | |
| Once the equations defining the system have been identified, a Simulink model will be implemented, conducted and evaluated. | Lab report. Class discussions. Quizzes |