BME 351 Introduction to Biofluid Mechanics

3 Credits, 3 Contact hours
Instructor: Max Roman, Ph.D.
Course Coordinator: Max Roman Ph.D.

Textbook(s)/Materials Required:

1) Applied Biofluid Mechanics, Lee Waite and Jerry Fine. McGraw-Hill; 1st edition, 2007 ISBN -10: 0-07-147217-7
2) Fluid Mechanics: Fundamentals and Applications, Yunus A Cengel and John M. Cimbala, 2nd Edition, McGraw Hill, 2010 ISBN: 978-0-07-352926-4
3) Introduction to Fluid Mechanics for Biomedical Engineering, Roman Max, (Instructor provided PDF textbook)

Course Description:

Introduction to the principles of fluid flow for biomedical engineers. Basic fluid principles such as properties of fluids, fluid statics, Bernoulli equation, conservation of mass and momentum, fluid kinematics, and the Navier-Stokes equation will be presented. Special emphasis will placed on flow in circular channels and viscous flow. Examples will be used throughout the course to emphasize biomedical engineering applications including the circulatory and pulmonary system and device design.

Prerequisites:

BME 302, Mech 236 and Mech 320

This is a required course for all students in the biomechanics track.

Course Learning Outcomes (CLO):

1. Gain the understanding of the underlying assumptions and models that are applied when solving fluid mechanics problems

2. Learn to differentiate between the various approaches and solutions applied to a wide variety of fluid mechanics problems related to physiological processes, medical devices, and laboratory setups as used for testing and measuring.
3. Reinforce the student's prior knowledge in calculus, differential equations, and engineering as it applies to fluid mechanics.
4. Computational Fluid Dynamics (CFD) and MATLAB will be introduced to emphasize Computer Aided Engineering (CAE) for designing medical devices. Interpret results of simulations to make design decisions.

Student Learning Outcomes:

Student outcome 1 - an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
Related CLO – 1,2,3,4

Student outcome 6 - an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
Related CLO – 2,4

Program Specific Criteria:

B- the capability to apply advanced mathematics (including differential equations and statistics) to solve the problems at the interface of engineering and biology
Related CLO – 1,2,3,4

C - the capability to apply advanced science and engineering to solve the problems at the interface of engineering and biology
Related CLO – 2,4

Course Topics:

Introduction to fluids and fluid properties; Viscosity: Newtonian and NonNewtonian fluids, Blood and its properties; Fluid statics, pressure vessels, capillary effect, rotating containers; Pressure and flow, kinetic knergy of the circulation; Bernoulli Equation, pressure measuring and metering devices, stents; blood pressure and the heart; Fluid kinematics: pathlines and streamlines; Conservation of mass/momentum; Stent migration force; Differential analysis of fluid flow; Rotational and irrotational flow, Navier-Stokes and Poiseuille flow, - Flow through aortic valves; The circulation, pulsatile flow, Womersly solution; Laminar flow and viscous flow in veins and arteries; Reynolds number; Pumps and the heart, power, diseases related to fluid flow; Introduction to microfluidics and Lab-on-Chip applications