ME 476 COURSE PROFILE

DEGREE PROGRAM: Mechanical Engineering

<table>
<tr><td>COURSE NUMBER: ME 476</td><td>COURSE TITLE: Biofluid Mechanics</td></tr>
<tr><td>REQUIRED COURSE OR ELECTIVE COURSE: Elective</td><td>TERMS OFFERED: Winter</td></tr>
<tr><td>TEXTBOOK / REQUIRED MATERIAL: Class notes.</td><td>PRE / CO-REQUISITES: MECHENG 320. II (4 credits)</td></tr>
<tr><td>COGNIZANT FACULTY: J. Grotberg

BULLETIN DESCRIPTION: This is an intermediate level fluid mechanics course which uses examples from biotechnology processes and physiologic applications including the cardiovascular, respiratory, ocular, renal, musculo-skeletal and gastrointestinal systems.</td><td>COURSE TOPICS:

1. Dimensional analysis (gastrointestinal and renal applications)
2. Approximation methods including regular and singular perturbations (biotechnology examples)
3. Particle kinematics in Eularian and Lagrangian reference frames (biotechnology examples)
4. Conservation of mass and momentum
5. Constitutive equations and Newtonian/non-Newtonian biofluid models (blood and mucus examples)
6. Kinematic and stress boundary conditions: rigid, flexible, porous(cardio-pulmonary examples)
7. Surface tension phenomena including Marangoni flows (pulmonary and ocular applications)
8. Flow and wave propagation in flexible tubes (cardio-pulmonary applications)
9. Oscillatory and pulsatile flows (cardio-pulmonary examples)
10. High Reynolds number flows and boundary layers (cardio-pulmonary applications)
11. Low Reynolds number flows (biotechnology examples)
12. Lubrication theory(hemodynamics of red blood cells, synovial fluid in joints)
13. Flow in porous media (ocular examples)
14. Video presentations of laboratory experiments covering: flow visualization, deformation of continuous media, rheological behavior of fluids, pressure fields and fluid acceleration, surface tension in fluid mechanics, secondary flow, fundamentals of boundary layers</td></tr>
<tr><td colspan="2">COURSE STRUCTURE/SCHEDULE:</td></tr>
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COURSE OBJECTIVES: **for each course objective, links to the Program Outcomes are identified in brackets.**	1. To teach students fundamental fluid mechanics (conservation laws and boundary conditions) at the intermediate level [1]/ 2. To teach students the unique features of biological flows, especially constitutive laws and boundaries [1]. 3. To teach students the application of fluid mechanics to physiology and biotechnology [1, 2, 4]. 4. To teach students approximation methods in fluid mechanics and their constraints [1]. 5. To teach students how to model fluid mechanical systems in biology [1, 4]. 6. To teach students how to reduce data from experiments in biological flows [1, 6].
COURSE OUTCOMES: **for each course outcome, links to the Course Objectives are identified in brackets.**	1. Obtain knowledge of fluid dynamical phenomena in biological systems [1, 2] 2. Enhance understanding of biotechnology-related flows [3, 5]. 3. Learn the relationship between fluid dynamics and normal/abnormal physiology [3, 5, 6]. 4. Develop the ability to scale and approximate fluid dynamical equations [1, 2]. 5. Learn techniques of perturbation methods and their application to biological flows [1, 2, 4] 6. Gain experience with free-boundary problems and their biological examples [3, 5, 6] 7. Understand boundary layer theory and its application to biological flows [1, 3, 5]. 8. Learn to model the non-Newtonian behavior of biofluids [2, 5].
ASSESSMENT TOOLS: **for each assessment tool, links to the course outcomes are identified**	1. Homeworks, including small team projects/assignments 2. Exams 3. Classroom participation

PREPARED BY: J. Grotberg
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