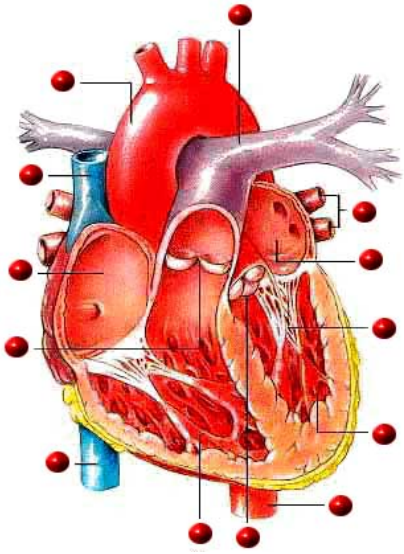
BIOFLUID DYNAMICS

MECH 433



Contact information

Dr. Dana Grecov
Mechanical Engineering
CEME 2060
822-6710
dgrecov@mech.ubc.ca

Class Format

Three 1-hour classes each week (M,W,F – 9.00-10.00)

Memorial Gymnasium Room 208

Guest lectures (2)

- David Mester, Manager, Vivitro Systems (prosthetic heart valve test equipment)
- Dr. Jerome Fryer, Chiropractor – synovial joints mechanics (confirmed)

Course Description

The need for engineers with integrated multidisciplinary knowledge is expected to grow along with the rapid advances in biomedical science and technology. This course elaborates on the application of fluid mechanics principles to major human organ systems. The course is an introduction to physiologically relevant fluid flow phenomena, underlying physical mechanisms from an engineering perspective. The focus of the course is on the integration of various fluid mechanics concepts to address relevant problems of the human body's systems.

Learning Objectives

By the end of the course it is expected that students will be able to:

- Understand the physiology and anatomy of studied systems,
- Analyze fluid mechanics models currently used for clinical research problems,

- Integrate fluid dynamics engineering concepts to examine and to model the biological flow in human body,
- Identify specific diseases and how they are related to fluid dynamics,
- Have the capability to carry out a biofluid dynamics design project..

Prerequisites

MECH 222 or equivalent.

Textbook

There is no required textbook for the course. Lecture notes will be provided on the course website. Informational sources could be found via the following textbooks:

1. C.Ross Ethier and Craigg A. Simmons, Introductory Biomechanics, Cambridge texts in Biomedical Engineering, 2007.
2. C. Kleinstreuer, Biofluid Dynamics: Principles and Applications, CRC Press, Taylor&Francis Group, 2006.
3. M. Zamir, The Physics of pulsatile flow, Springer-Verlag NY, 2000.
4. J. N. Mazumdar, Biofluid Mechanics, World Scientific, 2004.
5. Y.C. Fung, Biodynamics: Circulation, Springer-Verlag NY, 1997.
6. L. Waite, Applied Biofluid Mechanics, McGraw Hill, 2007
7. L. Waite, Biofluid Mechanics in Cardiovascular Systems, McGraw-Hill , 2006.

A general fluid mechanics textbook will be useful (White, Cimbala)

Assessment Strategies

Quizzes

Three quizzes of 1 hour duration will be given during the term. Typically it will have the open-book/notes format. It will represent 60% of the final grade.

Problem sets

After each major topic (5), an assignment based on a problem set will be distributed. It will represent 10% of the final grade.

Term Projects

Students will individually perform a biofluid dynamics design project from a list of possibilities provided by the instructor. Examples include: redesign of ventricular assisted device, design of a graft, redesign of an artificial heart valve. The design or redesign will be done using approaches presented in the lectures. It will represent 28% of the final grade.

Seminar (6-7)

Times and dates have to be decided. Attendance and participation are required (2%)

Grading System

Three Quizzes (3x20%)	60%
Assignments (5)	10%
Term project	28%
Seminar	2%

Detailed Course Outline

1. **Review of basic fluid mechanics**
2. **Biorheology**

Constitutive equations. Non-Newtonian fluid models.

3. **Circulatory biofluid mechanics**

Circulatory system physiology. Function of circulatory system, circulation in heart, blood and lymphatic vessels. Blood properties. Hemorheology.

Models for blood flow: Steady flow in tubes. Pulsatile flow in a rigid tube. Pulsatile flow in an elastic tube. Wave propagation in elastic tubes.

Applications in circulatory system: Blood flow dynamics in arteries and veins. Flow in specific vessels and arteries. Heart-valve hemodynamics. Diseases related to obstruction of blood flow. Stroke. Heart injury.

4. **Synovial fluid in joints**

Synovial joints physiology. Function of synovial fluid. Diseases. Synovial fluid properties and rheology. Lubrication theory. Application for synovial fluid flow. Arthritis. Knee and Hip injury.

5. **Biofluid dynamics of the human brain.**

Cerebrospinal fluid. Cerebral blood flow. Blood brain barrier. Brain diseases.

6. **Respiratory biofluid mechanics**

Respiratory system physiology. Alveolar ventilation. Air flow in the lungs. Mechanics of breathing. Gas exchange and transport.

7. **Flow and pressure measurement techniques in human body.**

Week	Topic
1	Review of basic fluid mechanics
2	Biorheology
3	Biorheology, Circulatory biofluid mechanics
4	Circulatory biofluid mechanics
5	Circulatory biofluid mechanics
6	Circulatory biofluid mechanics
7	Circulatory biofluid mechanics
8	Synovial fluid in joints
9	Synovial fluid in joints
10	Biofluid dynamics of the human brain.
11	Respiratory biofluid mechanics
12	Respiratory biofluid mechanics

13	Flow and pressure measurement techniques in human body.