

1. Course Information

Hemodynamics

Medical Biophysics 4535/9510, Biomedical Engineering 9535

Fall Term 2017

Biophysics related to blood flow: Biomechanical properties of blood, arteries, and veins; pressure, flow, and Poiseuille's law; optimality principles; fluid flow conservation laws and their mathematical description; pulsatile flow in rigid vessels; wave propagation in elastic vessels; structure and blood rheology of the microcirculation; oxygen delivery and flow regulation.

Lectures:

Wednesday/2:30-4:30pm/ NCB-295

Requisites:

Prerequisite(s): Medical Biophysics 3501A, Medical Biophysics 3503G, Medical Biophysics 3505F and Medical Biophysics 3507G; or permission of the department.

Senate regulation regarding the student's responsibility regarding requisites:

Unless you have either the requisites for this course or written special permission from your Dean to enroll in it, you may be removed from this course and it will be deleted from your record. This decision may not be appealed. You will receive no adjustment to your fees in the event that you are dropped from a course for failing to have the necessary prerequisites.

Accessibility Statement

Please contact the course instructor if you require material in an alternate format or if you require any other arrangements to make this course more accessible to you. You may also wish to contact Services for Students with Disabilities (SSD) at 661-2111 x 82147 for any specific question regarding an accommodation.

2. Instructor Information

Instructors	Email	Office	Phone	Office Hours
Dr. Daniel Goldman (Course Coordinator)	dgoldma2@uwo.ca	MSB 412	x80213	M 3-4pm, Or by appointment

WebCT:

Students with WebCT issues should contact the Computer Support Centre at 519 661-3800 or fill out the WebCT webform:

<https://servlet.uwo.ca:8081/vistahelpdesk/controller.jsp>

Slides/notes and assignments will be posted online using WebCT OWL.

3. Course Syllabus

Learning Outcomes

By the end of the course students will be able to:

- (i) Demonstrate an understanding of the basic biomechanical properties of the blood, arteries and veins.
- (ii) Demonstrate an understanding of the principles of blood flow in arteries, including mass conservation, force balance, pressure, viscosity, shear stress, inertia, and vessel elasticity, and how these are involved in pulsatile flow and wave propagation.
- (iii) Demonstrate an understanding of the principles of blood flow in the microcirculation, including the role of discrete red blood cells in producing the Fahraeus effect, the Fahraeus-Lindqvist effect, and plasma skimming at diverging bifurcations.
- (iv) Demonstrate an understanding of oxygen transport by diffusion and convection, the implications for flow regulation, and some of the ways this regulation is accomplished.
- (v) Apply the above blood flow and mass transport principles, and their mathematical descriptions, to quantitative analysis of problems in vascular physiology and pathophysiology.

Students will achieve the above learning outcomes through solving problem assignments and participating in class discussions.

Course Topics and Assignments

Date	Topic	Assignment
Sep 13	Intro/The circulatory system: Blood, heart, arteries and veins	
Sep 20	Basic flow dynamics: Pressure, flow, resistance, and Poiseuille's Law	#1
Sep 27	Applications of Poiseuille's Law: Electrical analogues and optimality	#2
Oct 4	Equations of fluid flow: Continuity, Bernoulli, Navier-Stokes	

Oct 11	READING WEEK	
Oct 18	Womersley flow: Pulsatile flow in rigid vessels	#3
Oct 25	Wave propagation: Pulsatile flow in elastic vessels	
Nov 1	Midterm Test (28%)	
Nov 8	Pulsatile flow	#4
Nov 15	Structure of the microcirculation	
Nov 22	Microvascular blood rheology	#5
Nov 29	Regulation of blood flow in skeletal muscle	
Dec 6	Microvascular oxygen delivery and modeling flow regulation	#6
TBA	Final Exam (42%)	

4. Course Materials

Recommended Textbook

Waite L & Fine J, Applied Biofluid Mechanics, McGraw-Hill, 2017

Supplementary Textbooks

Fung YC, Biomechanics: Circulation, Springer-Verlag, 1997

Keener J & Sneyd J, Mathematical Physiology, Springer-Verlag, 1998

Oates C, Cardiovascular Hemodynamics and Doppler Waveforms Explained, Greenwich Medical Media, 2001

5. Evaluation

30% Assignments: There will be a total of 6 assignments, each worth 5%. They will be handed out (or posted online) during the lecture on the date noted, and will be due at the beginning of the following lecture. Late assignments will usually not be accepted. If you work on an assignment as a group, you may hand in a single assignment as long as the names and student numbers of all contributing students are indicated.

28% Midterm Test: Closed-book format, covering up to and including Womersley flow in rigid vessels.

42% Final Exam: Closed-book format, covering all course material.

Regular class attendance and participation are expected.

6. Additional Information/Statements

Statement on Use of Electronic Devices

During tests and exams, calculators are permitted for numerical evaluation of results, but may not be used for graphing or symbolic calculations (algebra, integration, etc.). No other electronic devices are allowed.

Statement on Academic Offences

“Scholastic offences are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, at the following website:

http://www.uwo.ca/univsec/handbook/appeals/scholastic_discipline_undergrad.pdf .”

Absence from course commitments

A. Absence for medical illness:

Students must familiarize themselves with the Policy on Accommodation for Medical Illness: <https://studentservices.uwo.ca/secure/index.cfm>

Statement from the Dean’s Office, Faculty of Science

If you are unable to meet a course requirement due to illness or other serious circumstances, you must provide valid medical or other supporting documentation to the Dean's office as soon as possible and contact your instructor immediately. It is the student's responsibility to make alternative arrangements with their instructor once the accommodation has been approved and the instructor has been informed. In the event of a missed final exam, a "Recommendation of Special Examination" form must be obtained from the Dean's Office immediately. For further information please see:

<http://www.uwo.ca/univsec/handbook/appeals/medical.pdf>

A student requiring academic accommodation due to illness, should use the Student Medical Certificate when visiting an off-campus medical facility or request a Record's Release Form (located in the Dean's Office) for visits to Student Health Services.

The form can be found at:

https://studentservices.uwo.ca/secure/medical_document.pdf

If individual assignments or classes are missed due to medical illness or other extenuating circumstances, accommodation should be discussed with the instructor.

B. Absence for non-medical reasons:

Non-medical absences from the midterm test or final exam, or more than 2 late or missing assignments, must be documented in order to receive accommodation. Such documentation must be submitted by the student directly to the appropriate Faculty Dean`s Office and not to the instructor. It will subsequently be the Dean`s Office that will determine if accommodation is warranted.

C. Special Examinations

A Special Examination is any examination other than the regular examination, and it may be offered only with the permission of the Dean of the Faculty in which the student is registered, in consultation with the instructor and Department Chair. Permission to write a Special Examination may be given on the basis of compassionate or medical grounds with appropriate supporting documents.

A Special Examination must be written at the University or an Affiliated University College no later than 30 days after the end of the examination period involved. To accommodate unusual circumstances, a date later than this may be arranged at the time permission is first given by the Dean of the Faculty. The Dean will consult with the instructor and Department Chair and, if a later date is arranged, will communicate this to Registrarial Services. If a student fails to write a scheduled Special Examination, permission to write another Special Examination will be granted only with the permission of the Dean in exceptional circumstances and with appropriate supporting documents. In such a case, the date of this Special Examination normally will be the scheduled date for the final exam the next time the course is offered.

Support Services:

Registrarial Services: <http://www.registrar.uwo.ca>

Academic Counselling (Science and Basic Medical Sciences):
<http://www.uwo.ca/sci/counselling/index.html>

USC Student Support Services: <http://westernusc.ca/service>

Student Development Centre:; <http://www.sdc.uwo.ca>

Student Health Services: <http://www.shs.uwo.ca/>

Students who are in emotional/mental distress should refer to Mental Health@Western for a complete list of options about how to obtain help:

<http://www.uwo.ca/uwocom/mentalhealth/>