Faculty of Engineering and Applied Science

CHEE 452 – TRANSPORT PHENOMENA IN PHYSIOLOGICAL SYSTEMS

Course Syllabus – Fall 2021

This is your course syllabus. Please download the file and keep it for future reference.

LAND ACKNOWLEDGEMENT

Queen's University is situated on traditional Anishinaabe and Haudenosaunee Territory.
See: http://www.queensu.ca/encyclopedia/t/traditional-territories

INCLUSIVITY STATEMENT

Queen's students, faculty, and staff come from every imaginable background – small towns and suburbs, urban high rises, Indigenous communities, and from more than 100 countries around the world. You belong here: https://www.queensu.ca/inclusive/.

TEACHING TEAM

COURSE INSTRUCTOR

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CHEE 452 (F 3-0-0.5 3.5)

COURSE DESCRIPTION[1]

This course is an introduction to the area of mass, momentum, and heat transfer processes in physiological systems. In this course the student will appreciate the role of transport phenomena in the function of organs and organ systems in the body, and develop the skills necessary to analyze models of biological transport processes in the context of the design of biomedical devices. (0/0/0/42/0)

Prerequisites: CHEE 223 and CHEE 330, or permission of the department

Exclusions: CHEE 412

PRE-REQUISITE KNOWLEDGE

This course applies knowledge developed in the prior transport courses (CHEE 223, CHEE 224 and CHEE 330) to problems that deal with physiological systems. This course complements and expands knowledge developed in CHEE 340 Biomedical Engineering and equips the students who follow the Biochemical Engineering option with knowledge that is essential in the understanding of transport processes in biological systems.

COURSE LEARNING OUTCOMES (CLO)

Specific course learning outcomes include:

CLO	DESCRIPTION	INDICATORS
CLO 1	Identify transport properties and analyze the mechanisms of molecular momentum, energy and mass transport.	KB-ES-TrPh (d)
CLO 2	Select, locate and orient coordinate systems for transport phenomena problems (including rectangular and curvilinear).	KB-ES-TrPh (d)
CLO 3	Formulate the differential forms of the equations of change for momentum, heat and mass transfer problems for steady-state and unsteady flows.	KB-ES-TrPh (b)
CLO 4	Create original solutions to fluid flow, heat transfer and mass transfer problems	KB-ES-TrPh (a) KB-ES-TrPh (b) KB-ES-TrPh (c) KB-ES-Biochem (b)
CLO 5	Develop original solutions to fluid flow in compliant and oscillatory systems	KB-ES-TrPh (a) KB-ES-TrPh (b) KB-ES-TrPh (c) KB-ES-Biochem (b)
CLO 6	Create original solutions to combined fluid flow and heat transfer, heat and mass transfer and fluid flow and mass transfer problems.	KB-ES-TrPh (a) KB-ES-TrPh (b) KB-ES-TrPh (c) KB-ES-Biochem (b)
CLO 7	Understand and appreciate physiology of the pulmonary, cardiovascular, and renal systems and how they can be modeled.	KB-ES-Biochem (b)

[1] Course Author(s): Brian Amsden, Lindsay Fitzpatrick. Queen's University holds a license for the use of the Course Author's Intellectual Property for CHEE 452.

This course develops the following attributes at the 4th year level:

Knowledge Base, Engineering Science (KB-ES): **BioChem (b)** Applies foundations of science, materials science, and engineering in biological, physiological, pharmaceutical and/or environmental problems or processes. **TrPh (a)** Formulates and applies integral mass, momentum and energy balances to do engineering calculations. **TrPh (b)** Formulates and applies differential mass, momentum and energy balances to do engineering calculations. **TrPh (c)** Analyzes convective transport of fluids in closed conduits and external flows. **TrPh (d)** Identifies mechanisms of momentum, heat and mass transfers and formulates and applies appropriate constitutive models to describe fluid behaviour.

COURSE EVALUATION

ASSESSMENT WEIGHTING

Assessment Tool	Assessment Due Date/Week	Weight	Alignment with CLOs
Assignments	**Weeks 4, 8, 12**	**15%**	**CLO1-7**
Term Tests	**Weeks 5, 9**	**50%**	**CLO1-7**
Test 1	Week 5 (Oct 4, 2021)	25%	CLO1-7
Test 2	Week 9 (Nov 1, 2021)	25%	CLO1-7
Final Exam	**Exam Period**	**35%**	**CLO1-7**
		100%	

ASSESSMENT DESCRIPTIONS

Assignments

This course has three marked assignments (also referred to as problem sets). Each assignment will require you to solve one or more complex problems. Some assignments may require you to discuss your findings and extend the concept to wider applications. More details about these assignments can be found in onQ.

Term Tests

This course has two Term Tests scheduled during the lecture and tutorial time (Monday 2:30 – 4:20pm). The tests exam are closed book and equation sheets will be provided with the question booklet. Tests will require you to solve complex problems and answer short and medium length questions about physiological systems. More details about these assignments can be found in onQ.

Final Exam

The final exam is closed book; equation sheets will be provided with the exam question booklet. Students must write their exam on the day and time scheduled by the University. You should not schedule vacations, travel, etc. during the exam period. The Term and Session Dates will indicate the final exam period session dates in each term.

GRADING

All assessments in this course will receive numerical percentage marks. The final grade you receive for the course will be derived by converting your numerical course average to a letter grade according to the established Grade Point Index.

Feedback on Assessments

The teaching team will provide feedback on graded activities. You can expect feedback on your assessments within seven days of the due date.

Accessing Your Final Grade

Your final grades will show on SOLUS. Official transcripts showing final grades will be available on the Official Grade Release Date. Please note that in official transcripts, a mark of IN (incomplete) is considered a grade, and your transcript is released with this grade.

COURSE MATERIALS

Recommended Textbook

Roselli, R. J.; Diller, K. R. Biotransport: Principles and Applications; Springer New York, 2011

(Available online from Queen's Library)

Other Material

All other course material is accessible via OnQ.

Required Calculator

A Casio 991 is required. **ONLY** this type of non-programmable, non-communicating calculator will be allowed during tests and exams.

Suggested Time Commitment

This course represents a study period of one semester spanning 12 weeks. Learners can expect to invest on average 7-9 hours per week in this course. Learners who adhere to a pre-determined study schedule are more likely to successfully complete the course.

WEEKLY COURSE OUTCOMES

Students are expected to augment lecture material through reading of associated sections of the textbook, and to practice execution of course principles by completing posted problem sets

Module	Lecture approach and content	Tutorial approach and content	Assessment (CLO)
Module 1 (Week 1)	• presentation of the physiology of the cardiovascular system • non-Newtonian nature of blood • compliant nature of blood vessels and • airway vessels • pulsatile nature of blood flow and breathing	Lecture	CLO7 Material is included on test 1, final exam
Module 2 (Week 2)	• overview of micro/macroscopic transport • review momentum transfer mechanisms • development of macroscopic momentum balance, energy balance, Hagen-Poiseuille equation	Lecture	CLO1 Material is included on test 1, assigned tutorial problems, problem set and final exam
Module 3 (Wks 3-5)	• hemodynamics and resistance to flow in blood vessels • compliance and resistance of flexible conduits • Windkessel model of arterial pressure • simple respiratory flow model • wave propagation in compliant vessels • flow across semi-permeable conduits with respect to filtration of blood in capillaries	Tutorial problems, Problem Set 1	CLO2, CLO3, CLO4, CLO5, CLO6 Material is included on Test 1, assigned tutorial problems, problem sets and final exam Problem Set 1 (Due Week 4)
Test 1 (Week 5)			Covers weeks 1-4 and CLO1-7 Worth 25 % of the final mark
Module 4 (Wks 6-10)	• single phase mass transfer • transport between phases; diffusion across a membrane • cellular transport mechanisms • macroscopic species balances • microscopic species conservation • gas exchange in the lungs and tissues	Take up Test, Tutorial Problems, Problem Set 2	CLO1, CLO2, CLO3, CLO4, CLO6 Material is included on test 2, assigned tutorial problems, problem sets and final exam Problem Set 2 (Due Week 8)
Test 2 (Week 9)			Covers weeks 5-7 and CLO1-7 Worth 25 % of the final mark
Module 5 (Wks 11-13)	• metabolism and regulation of body temperature • physiological radiative, convective,	Take up Midterm, Tutorial Problems, Problem Set 3	CLO1,2,3,4,6,7

	conductive heat transfer • heat transfer resistance in the body		Material is included on assigned tutorial problems, problem sets and final exam Problem Set 3 (Due Week 12)
Final Exam			Covers Wks 1-13 and CLO1-7. Worth 35 % of the final mark

COURSE COMMUNICATION

NETIQUETTE

In this course, you may be expected to communicate with your peers and the teaching team through electronic communication. You are expected to use the utmost respect in your dealings with your colleagues or when participating in activities, discussions, and online communication.

Following is a list of netiquette guidelines. Please read them carefully and use them to guide your online communication in this course and beyond.

1. Make a personal commitment to learn about, understand, and support your peers.
2. Assume the best of others and expect the best of them.
3. Acknowledge the impact of oppression on the lives of other people and make sure your writing is respectful and inclusive.
4. Recognize and value the experiences, abilities, and knowledge each person brings.
5. Pay close attention to what your peers write before you respond. Think through and re-read your writings before you post or send them to others.
6. It's alright to disagree with ideas, but do not make personal attacks.
7. Be open to be challenged or confronted on your ideas and challenge others with the intent of facilitating growth. Do not demean or embarrass others.
8. Encourage others to develop and share their ideas.

QUESTIONS ABOUT COURSE MATERIAL

Questions or comments regarding the course material that can be of benefit to other students should be posted in the Q&A forum on the class website. The instructor, TAs, and students are encouraged to answer these questions directly in the discussion forum for the benefit of everyone in the course.

COURSE ANNOUNCEMENTS

The instructor will routinely post course news in the Announcements section on the main course homepage on OnQ. Please sign up to be automatically notified by email when the instructor posts new information in the Announcements section. Instructions on how to modify your notifications are found in the **Begin Here** section of the onQ course site.

OFFICE HOURS

In addition to interaction in the Q&A discussion forums, you will have the opportunity to interact with either a TA or the instructor through office hours. The instructor will provide a schedule of availability at the beginning of the term.

CONFIDENTIAL MATTERS

If you have a confidential matter you would like to discuss with your instructor, their contact details are on the first page of this document. Expect email replies within 48 hours.

STANDARD FEAS INFORMATION

COURSE POLICIES

Please review the following policies concerning copyright, academic integrity, absences and academic accommodations:

COPYRIGHT

Course materials created by the course instructor, including all slides, presentations, synchronous and asynchronous course recordings, handouts, tests, exams, and other similar course materials, are the intellectual property of the instructor. It is a departure from academic integrity to distribute, publicly post, sell or otherwise disseminate an instructor's course materials or to provide an instructor's course materials to anyone else for distribution, posting, sale or other means of dissemination, without the instructor's ***express consent***. A student who engages in such conduct may be subject to penalty for a departure from academic integrity and may also face adverse legal consequences for infringement of intellectual property rights and, with respect to recordings, potentially privacy violations of other students.

ACADEMIC INTEGRITY

As an engineering student, you have made a decision to join us in the profession of engineering, a long-respected profession with high standards of behaviour. As future engineers, we expect you to behave with integrity at all times. Please note that Engineers have a duty to:

- Act at all times with devotion to the high ideals of personal honour and professional integrity.
- Give proper credit for engineering work

The standard of behaviour expected of professional engineers is explained in the Professional Engineers Ontario Code of Ethics. Information on policies concerning academic integrity is available in the Queen's University Code of Conduct, in the Senate Academic Integrity Policy Statement, on the Faculty of Engineering and Applied Science website, and from your instructor.

Departures from academic integrity include plagiarism, use of unauthorized materials or services, facilitation, forgery, falsification, unauthorized use of intellectual property, and collaboration, and are antithetical to the development of an academic community at Queen's. Given the seriousness of these matters, actions which contravene the regulation on academic integrity carry sanctions that can range from a warning or the loss of grades on an assignment to the failure of a course to a requirement to withdraw from the University.

In the case of online or remotely proctored exams, impersonating another student, copying from another student, making information available to another student about the exam questions or possible answers,

posting materials to online services, communicating with another person during an exam or about an exam during the exam window, or accessing unauthorized materials, including internet sources and using unauthorized materials, including smart devices, are actions in contravention of academic integrity.

Late Policy

Any applicable late penalties are described in the details for each assessment. In the event of extenuating circumstances, you must follow the policies for requesting an academic consideration (please see below). Note that unacceptable reasons include extra-curricular activities, travel plans, generally behind on schoolwork, etc. In the absence of an approved consideration request, the normal late penalty will apply as described in the assignment or any course/departmental policies.

Invalid Exams

An exam may be declared invalid in case of an interruption in an in-person examination; if the instructions in a remote or online exam were not followed; if the student uploads wrong materials; or if a situation arises where the integrity of the exam cannot be verified. If an exam is declared invalid, the student may be granted a re-write.

Absences (Academic Considerations) and Academic Accommodations

For absences and academic accommodations please review the information on the FEAS website.

ACADEMIC AND STUDENT SUPPORT

Queen's has a robust set of supports available to you including the Library, Student Academic Success Services (Learning Strategies and Writing Centre), and Career Services. Learners are encouraged to visit the Faculty of Engineering and Applied Science Current Students web portal for information about various other policies such as academic advisors, registration, student exchanges, awards and scholarships, etc.

Individual Needs and Support

If you have a disability or health-related condition that may require academic accommodations, please approach the Queen's Accessibility Services. The staff at Accessibility Services are available by appointment to develop individualized accommodation plans, provide referrals, and assist with advocacy. The sooner you let us know your needs, the better we can assist you in achieving your learning goals. For questions or assistance with requesting Academic Consideration or Accommodation, contact the FEAS Academic Accommodation Coordinator at engineering.aac@queensu.ca

Every effort has been made to provide course materials that are accessible. For further information on accessibility compliance of the educational technologies used in this course, please consult the links below.

Educational Technology	Accessibility Compliance Information
onQ (Brightspace Learning Management System by D2L)	https://www.d2l.com/accessibility/standards/
MS-Teams	https://support.microsoft.com/en-us/office/accessibility-support-for-microsoft-teams-d12ee53f-d15f-445e-be8d-f0ba2c5ee68f
Zoom	https://zoom.us/accessibility

If you find any element of this course difficult to access, please discuss with your instructor how you can obtain an accommodation.

Religious Observance

Students in need of accommodation for religious observance are asked to speak to their professor within a week of receiving their syllabus. Note also that alternative assignments are considered a "reasonable accommodation" under the Ontario Human Rights Code. Students with questions about their rights and responsibilities regarding religious accommodation should contact the Chaplain via Chaplain@queensu.ca.

Technical Support

Some basic comfort level with basic hardware and software skills are required for this course. If you require technical assistance, please contact Technical Support.

Supportive Personal Counselling

If at any time you find yourself feeling overwhelmed, anxious, sad, lonely, or distressed, consider confidential supportive counselling offered by the embedded counselors at the Student Wellness Service Faculty of Engineering and Applied Science.