Faculty of Engineering and Applied Science

CHEE 330 HEAT AND MASS TRANSFER

Course Syllabus – Fall 2021

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

LAND ACKNOWLEDGEMENT

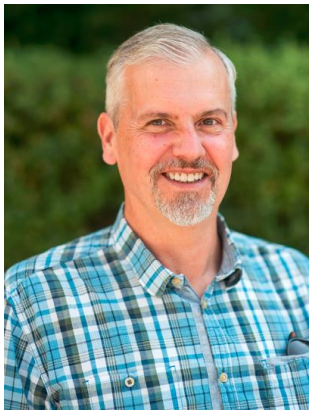
Queen's University is situated on traditional Anishinaabe and Haudenosaunee Territory.
See: http://www.queensu.ca/encyclopedia/t/traditional-territories

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 330 (F 3-0-0.5 3.5)

COURSE DESCRIPTION[1]

This course follows a unified approach to introduce the physical origins and rate equations of heat and mass transfer. The principal topics covered include identification of the driving forces for heat and mass diffusion, development of transport models from first principles, steady state and transient solutions, and convective transfer. The boundary layer analogies are introduced. Closed form analytical solutions and correlations derived from dimensional analysis are used to estimate the heat and mass transfer convection coefficients. (0/0/0/42/0) (Mathematics/Natural Sciences/Complementary Studies/Engineering Science/Engineering Design)

PREREQUISITES: CHEE 210 and CHEE 223, or permission of the department.

PRE-REQUISITE KNOWLEDGE

This course is designed for learners with background on fluid mechanics, thermodynamics and calculus.

COURSE LEARNING OUTCOMES (CLO)

By the end of this course, students should be able to:

CLO	DESCRIPTION	INDICATOR
CLO 1	Identify mechanisms of heat and mass transfer in order to formulate rate equations.	KB-ES (Transport Phenomena)
CLO 2	Develop transport models based on the differential equations of heat and mass transfer and their simplified forms; identify suitable boundary conditions.	KB-ES (Transport Phenomena) PA-Formulate
CLO 3	Solve the differential equations for steady-state, one-dimensional problems; and non-steady state problems.	KB-ES (Transport Phenomena) PA-Solve
CLO 4	Estimate heat and mass transfer coefficients based on dimensional analysis, boundary layer analysis and similarity between momentum, heat and mass transfer.	KB-ES (Transport Phenomena)
CLO 5	Solve problems involving convective heat and mass transfer in one phase and two-phase systems	KB-ES (Transport Phenomena)

COURSE EVALUATION

ASSESSMENT WEIGHTING

Assessment Tool	Due Date	Weight	Alignment with CLOs
Quizzes	**Weeks 4, 8**	**35%**	**1, 2, 3, 4, 5**
Quiz I	Week 4	15%	1,2
Quiz II	Week 8	20%	1,2,3
Assignment (in groups of 2 or 3*)	**Weeks 3, 6, 10**	**15%**	**1, 2, 3, 4, 5**
A I	Day 7 of Week 3	5%	1,2
A II	Day 7 of Week 6	5%	2,3
A III	Day 7 of Week 10	5%	4,5
Comprehension Checks in Class	**Throughout Term**	**10%**	**1, 2, 3, 4, 5**
Final Exam	Exam Period	**40%**	**1, 2, 3, 4, 5**
		100%	

ASSESSMENT DESCRIPTIONS

Quizzes

There are 2 quizzes in this course. These quizzes are designed to provide learners with immediate feedback on their knowledge. These quizzes will be 60 minutes and likely to be held during the double lecture on Mondays in Week 4 and 8.

Assignments

There are three assignments in this course. Each assignment will require you to solve 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.

Comprehension Checks

During the lecture, your comprehension will be checked by answering multiple choice and other questions using Qlicker.

Final Exam

The final exam is closed book. 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.

Students are expected to complete their work in a timely fashion. The course instructor will provide notification (on course website) of due dates and any revisions thereof. Submissions after the due date will be penalized at up to 25% per day unless suitable justification is provided.

Unless other arrangements have been approved, departmental policies regarding late and missed assignments, and missed quizzes/exams will be followed. Students must pass the individual examination component (combined mark on midterm or quizzes and final) to pass the course, as stated by departmental policies.

Feedback on Assessments

The teaching team will provide feedback on graded activities. You can expect feedback on your assessments within an appropriate time after 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

Required Textbook

"Heat and Mass Transfer", by Welty, Rorrer and Foster (WRF). This custom textbook is available from the campus bookstore in hard copy and e-book formats. It is compiled from the textbook "Fundamentals of Momentum, Heat, and Mass Transfer" by the same authors, 6th edition, published by Wiley in 2015 (Chapters 15-30). This custom textbook is listed as mandatory. The original textbook is acceptable. Please note that the 5th edition of the same textbook by Welty, Wicks, Wilson, Rorrer (WWWR) is also acceptable (2008).

Other Material

Bergman, T.L., Lavine, A.S., Incropera, F.P. and DeWitt, D.P., "Fundamentals of heat and mass transfer", 7th Ed. Wiley (Incropera). Brodkey, R.S. and Hershey, H.C., “Transport Phenomena: A Unified Approach”, McGraw-Hill (Brodkey). A copy of each of these textbooks has been placed on reserve at Queen’s Library.

All course materials (e.g. class notes; tutorials; assignments; problem sets; equation sheets, etc.) are available on the CHEE 330 onQ site, which is the primary LMS used for this course

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.

COURSE OVERVIEW

CHEE 330 || Module overview			
Course learning outcomes (CLO): Students will be able to: **1. Identification of mechanisms of heat and mass transfer. Formulation of rate equations.** **2. Development of transport models based on the differential equations of heat and mass transfer and their simplified forms; identification of suitable boundary conditions.** **3. Solutions of the differential equations for steady-state, one-dimensional problems; solutions for non-steady state problems.** **4. Estimation of heat and mass transfer coefficients based on dimensional analysis, boundary layer analysis and similarity between momentum, heat and mass transfer.** **5. Solution of problems involving convective heat and mass transfer in one phase and two phase systems**			
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** *In-person lecture & lecture slides (which may have omitted content) available on onQ*	**Tutorials**** *In-person tutorial. Slides available on onQ*	**Assessment (CLO, and % of course grade)**
Module 1 (Wks 1-3)	**Topic I: Introduction to Heat and Mass Transfer** **Topic II: Fundamentals of Heat Transfer (CLO1, CLO2)** • Modes of heat transfer • Conduction • Thermal properties • Convection • Radiation • Combined mechanisms	Tutorials 1-3 (CLO1, CLO2)	Material is included on Quiz I (CLO1, CLO2) Group assignment #1 (5%, CLO1, CLO2) Comprehension checks (3%,CLO1, CLO2)
Quiz I	**Covers Module 1**		***Quiz I:*** *Questions (which may include multiple choice) and problems which will target CLO1*

			and 2, worth 15% of course grade
Module 2 (Wks 4-5)	**Topic III: Fundamentals of Mass Transfer (CLO1, CLO2)** • Molecular mass transfer, Fick's rate equation • The diffusion coefficient • Introduction to convective mass transfer • Steady-state molecular diffusion	Tutorials 4,5 (CLO1, CLO2)	Material is included on Quiz II (CLO1, CLO2) Comprehension check (2%CLO1, CLO2)
Module 3 (Wks 6-7)	**Topic IV: Differential Equations of heat transfer – Solutions for one dimensional steady-state and transient problems (CLO2, CLO3)** • Conservation of energy • Derivation of differential energy equations • Special forms • Boundary conditions • Solutions for 1D, steady-state conduction without heat generation • Solutions for 1D, steady-state conduction with heat generation • Unsteady-state heat transfer	Tutorials 6,7 (CLO2, CLO3)	Material is included on Quiz II (CLO2, CLO3) Group assignment #2 (5%, CLO2, CLO3) Comprehension checks (2%,CLO2, CLO3)
Module 4 (Wks 8)	**Topic V: Differential Equations mass transfer – Solutions for one dimensional steady-state and transient problems (CLO2, CLO3)** • Derivation of mass transfer equations • Special forms • Boundary conditions • Solutions for 1D, steady-state mass transfer	Tutorial 8 (CLO2, CLO3)	Material is included on final (CLO2, CLO3) Comprehension checks (1%,CLO2, CLO3)

	• Solutions for 1D systems with chemical reaction		
Quiz II	**Covers Module 1 – 3**		***Quiz II:*** *Questions (may include multiple choice) and problems which will target CLO1,2 and 3, worth 20% of course grade*
Module 5 (Wk 9-11)	• Dimensional analysis • Boundary layer analysis • Momentum, heat and mass transfer analogies • Convective heat and mass transfer calculations	Tutorial 10, 11 (CLO4, CLO5)	Material is included on final (CLO4, CLO5) Group assignment #3 (5%, CLO4, CLO5) Comprehension check (3%,CLO4,CLO5)
Module 6 (Wk 12)	**Topic VII: Convective Mass Transfer between Two Phases (CLO5, CLO6)** • Two-resistances theory • Individual and overall mass transfer coefficients	Tutorial 12 (CLO4,CLO5)	Material is included on final (CLO5) Comprehension check (1%,CLO5)
EXAM	**Covers Module 1 – 6**		***Final exam:*** *Questions (which may include multiple choice) and problems which target all CLO, worth 40% of course grade*

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/
Qlicker	https://qlicker.queensu.ca/

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.