Transport Phenomena II (Heat and Mass)

CENG 3220

3 credits

Lecture: Monday, 1:30 PM – 2:50 PM. Room: 6602

Friday, 9:00 AM – 10:20 AM. Room: 6602

Tutorial: Thursday, 6:00 PM – 6:50 PM. Room: 1409

Prerequisites: CENG 2210 Thermodynamics,

Recommendations: CENG 2220 Transport I, MATH 2011 Introduction to Multivariable Calculus

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Teaching Assistants:

Course materials and Administrative: TBA

UG TA (Tutorial and some others): TBA

Course Description

Motivation: To understand rates and modes of heat and mass transfer; have the ability to design heat and mass systems

Example Applications: Energy-conversion devices (rechargeable batteries, fuel cells, engines, turbines), combustion, integrated circuits, human biology

Cases to deal with: Transport phenomena in chemical processes. Fluid flow in pipes and channels. Conductive, forced, and free convective and radiative heat transfer. Diffusive and convective mass transport. Coupling of transport and chemical reactions. Analysis and design of heat exchangers and contacting processes for separation and reaction. Numerical solutions and simulations of complex systems.

Theories and applications: Fick's law. Steady and unsteady diffusion. Mass transfer coefficients. Simultaneous momentum and mass transfer. Fourier's law. Steady and unsteady thermal conduction. Heat transfer coefficients. Heat exchangers.

Expected Learning Outcomes:

After this course, students should be able to

- solve problems involving steady and unsteady heat conduction, convection, and radiation.
- solve problems involving mass transfer due to diffusion, chemical reaction, and convection
- size some basic heat and mass transfer equipment
- apply engineering judgment, including an appreciation of cost and safety
- extend the solving ability to problems involving biological and environmental systems

Course Requirements and Policies:

Lectures: The lectures include questions, quizzes, problem-solving, etc. Each class would start with quizzes to remind essential concepts from the previous class. Students are encouraged to participate in the courses through questions and discussions. However, please be reminded that spending time on electronic devices, including mobile phones or other stuff that can disturb classmates, should be avoided. Please take the rules seriously and follow them as a basic courtesy to the instructor and fellow students. We will not allow anyone to disrupt the learning of other students.

Tutorials: This session will help you solve problems and practice other problems.

Quizzes: Classes will start with quizzes through Canvas. You will be required to mark the answers and submit them to Canvas.

Homework: Students will do homework to review the concepts they learned in class. They are encouraged to discuss their problems with peers to find solutions. However, students who cheat or engage in other behaviors that violate academic integrity will receive zero points. Please see "Academic Integrity" below for more details.

Exams: Students will take two main examinations: mid-term and final. The mid-term exam will focus on fundamental concepts and problem-solving skills. The final exam will be more comprehensive and include all the subjects and skills that students learned throughout the semester.

Academic Integrity: Students should follow the rules for academic integrity: https://acadreg.ust.hk/generalreg.html. Please pay special attention to the offense of plagiarism, which involves claiming credit for others' work as if it is your own, e.g., copying classmates' homework or using the information on the internet without referencing the source. Serious offenders will be referred to the university for disciplinary action.

Assessments:

Parts	Points	Note
Quizzes	25	All the quizzes are through Canvas. Each quiz has an equal weight for the total points. The lowest three scores will not be included in the points.
Homework (HW)	25	There are two homework assignments. Each assignment has equal weight for the total points. Late submissions of homework will have zero points, as answers will be released soon after the deadlines.
Mid-term exam	15	In-person on campus
Final exam	35	In-person on campus. Full coverage

Required Texts and Materials

Main textbook: "Fundamentals of Momentum, Heat, and Mass Transfer, 7th Edition"; James Welty, Gregory L. Rorrer, David G. Foster; ISBN: 978-1-119-49541-3; February 2019; WRF

*E-book purchase: https://w5.ab.ust.hk/cgi-bin/std_cgi.sh/WService=broker_ba_p/prg/ba_stdt_main.r

HKUST Bookstore at cpust@supretail.com.hk or 23586400.

*E-book rent is also possible from VitalSource: https://www.vitalsource.com/products/fundamentals-of-momentum-heat-and-mass-transfer-james-welty-gregory-l-v9781119495413

Another possible textbook: "Introductory Transport Phenomena"; R. Byron Bird, Warren E. Stewart, Edwin N. Lightfoot, Daniel J. Klingenberg; ISBN: 978-1-118-77552-3; Wiley (December 2014); BSLK

*E-book and rent are available from https://www.wiley.com/en-us and https://www.vitalsource.com/, respectively.

Tentative Schedule

#	Dates	Lecture topic	Notes
1	Sep 1 (M)	Introduction	
2	Sep 5 (F)	Fundamentals of heat transfer	
3	Sep 8 (M)	Fundamentals of heat transfer	
4	Sep 12 (F)	Differential equations of heat transfer	Quiz starts
5	Sep 15 (M)	Differential equations of heat transfer	
6	Sep 19 (F)	1D steady-state – Plane wall and composite walls	Tutorial starts
7	Sep 22 (M)	1D steady-state – Hollow cylinder & sphere	
8	Sep 26 (F)	TBA	
9	Sep 29 (M)	TBA	
10	Oct 3 (F)	1D steady-state – Energy generation	
11	Oct 6 (M)	1D steady-state – Energy generation & extended surface	
12	Oct 10 (F)	1D steady-state – Extended surface	**HW1 release**
13	Oct 13 (M)	1D steady-state – Extended surface / Unsteady state	
14	Oct 17 (F)	Unsteady state / Review for midterm exam	
15	Oct 20 (M)	***Midterm Exam***	
16	Oct 24 (F)	Unsteady state – lumped parameter	
17	Oct 27 (M)	Unsteady state – lumped parameter	
18	Oct 31 (F)	Unsteady state – Bi modulus	
	Nov 3 (M)	*No class*	
	Nov 7 (F)	*No class*	
19	Nov 10 (M)	Unsteady state – Semi-infinite wall	
20	Nov 14 (F)	Heat-transfer equipment	
21	Nov 17 (M)	Fundamentals of Mass Transfer & Nonstationary Media	
22	Nov 21 (F)	Fundamentals of Mass Transfer & Nonstationary Media	
23	Nov 24 (M)	Stationary Medium / Homogeneous Chemical Reaction and Unsteady-State	**HW2 release.** Last tutorial.
24	Nov 28 (F)	Homogeneous Chemical Reaction and Unsteady-State	Last quiz
		Study Break	
		Final Exam	

Due for HWs: One week after the release