Transport Phenomena II (Heat and Mass)

CENG 3220

3 credits

Lecture: Tuesday and Thursday, 4:30 PM – 5:50 PM. Room: 2463

Tutorial: Tuesday 06:00 PM – 06:50 PM. Room: 1527

Prerequisites: CENG 2210 Thermodynamics,

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

Name: Prof. Yoonseob Kim

Email: yoonseobkim@ust.hk

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 the 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 classes through questions and discussions. However, please be reminded that spending time on electronic devices, including mobile phones or other stuff, which can disturb classmates, should be avoided. In general, 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 would start with quizzes through the Canvas. You will be required to mark the answers and submit them to the Canvas.

Homework: Students will do homework to review the concepts that they learned in the classes. Students are encouraged to discuss with peers to get to the solutions to the problems. However, students who did cheating or engage in other behaviors that violate the integrity of academics will receive zero points. Please see below "Academic Integrity" for more details.

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

Academic Integrity: Students should follow academic integrity rules: 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 the homework of classmates, 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	18 quizzes through the Canvas. Each quiz has equal weight for the total points. The lowest three scores will not be included in the points.
Homework (HW)	25	2 HWs. Each homework has equal weight for the total points. Late submissions of HWs 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 3 (Tue)	Introduction	
2	Sep 5 (Thu)	Fundamentals of heat transfer	
3	Sep 10 (Tue)	Fundamentals of heat transfer	
4	Sep 12 (Thu)	Differential equations of heat transfer	Quiz starts
5	Sep 17 (Tue)	Differential equations of heat transfer	
6	Sep 19 (Thu)	1D steady-state – Plane wall and composite walls	Tutorial starts
7	Sep 24 (Tue)	1D steady-state – Hollow cylinder & sphere	
8	Sep 26 (Thu)	1D steady-state – Energy generation	
	Oct 1 (Tue)	*Public holiday*	
9	Oct 3 (Thu)	1D steady-state – Energy generation & extended surface	
10	Oct 8 (Tue)	1D steady-state – Extended surface	
11	Oct 10 (Thu)	1D steady-state – Extended surface	HW1 release
12	Oct 15 (Tue)	1D steady-state – Extended surface / Unsteady state	
13	Oct 17 (Thu)	Unsteady state / Review for midterm exam	
14	Oct 22 (Tue)	***Midterm Exam***	
	Oct 29 (Thu)	*No class*	
	Oct 31 (Tue)	*No class*	
15	Nov 5 (Thr)	Unsteady state – lumped parameter	
16	Nov 7 (Tue)	Unsteady state – Bi modulus	
17	Nov 12 (Thu)	Unsteady state – Semi-infinite wall	
18	Nov 14 (Tue)	Heat-transfer equipment	
19	Nov 19 (Thu)	Fundamentals of Mass Transfer & Nonstationary Media	
20	Nov 21 (Tue)	Fundamentals of Mass Transfer & Nonstationary Media	HW2 release. Last tutorial.
21	Nov 26 (Thu)	Stationary Medium / Homogeneous Chemical Reaction and Unsteady-State	
22	Nov 28 (Tue)	Homogeneous Chemical Reaction and Unsteady-State	Last quiz
		Study Break	
		Final Exam	

Due for HWs: One week after the release