CENG 3220 Transport Phenomena II (Heat and Mass)

Department of Chemical and Biological Engineering, HKUST, Fall 2022

Instructor:

Prof. Yoonseob Kim, yoonseobkim@ust.hk, CYT-2002

Office hours: By appointment.

Teaching Assistants:

Course materials: To be decided

Administrative: To be decided

UG TA: To be decided

Logistics:

3 credits

Lecture: Tuesday and Thursday 3:00 PM – 4:20 PM. Room: 6602 (Lift 31-32)

Tutorial: Thursday 06:00 PM – 06:50 PM. Room: 2302 (Lift 17-18)

Course 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.

Prerequisites: CENG 2210 Thermodynamics,

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

Comprehensive 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.

Grading

Parts	Points	Note
Class participation	10	Students will get 0.25 points for each participation. Also, no matter how many times students participate on the same day, students will only get 0.5 points per day. To claim your points, email to the TA, copying YSK, noting your participation. Only in-person questions are counted.
Quizzes	20	20 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)	20	3 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

Tentative Schedule

#	Dates	Lecture topic	Notes
1	Sep 5 (Tue)	Introduction	
2	Sep 7 (Thu)	Fundamentals of heat transfer	
3	Sep 12 (Tue)	Fundamentals of heat transfer	
4	Sep 14 (Thu)	Differential equations of heat transfer	Quiz starts
5	Sep 19 (Tue)	Differential equations of heat transfer	Tutorial starts from Sep 22 (Thu).
6	Sep 21 (Thu)	1D steady-state – Plane wall and composite walls	
7	Sep 26 (Tue)	1D steady-state – Hollow cylinder & sphere	
8	Sep 28 (Thu)	1D steady-state – Energy generation	
9	Oct 3 (The)	1D steady-state – Energy generation & extended surface	
10	Oct 5 (Thu)	1D steady-state – Extended surface	**HW1 release**
11	Oct 10 (Tue)	1D steady-state – Extended surface	
12	Oct 12 (Thu)	Unsteady state	

13	Oct 17 (Tue)	Review for midterm exam	
14	Oct 19 (Thu)	***Midterm Exam***	
15	Oct 24 (Thu)	Unsteady state – lumped parameter	
16	Oct 26 (Thu)	Unsteady state – Bi modulus	
17	Oct 31 (Thu)	Unsteady state – Semi-infinite wall	
18	Nov 2 (Thr)	Heat-transfer equipment	
	Nov 7 (The)	No Class	
	Nov 9 (Thu)	No Class	
19	Nov 14 (Thu)	Fundamentals of Mass Transfer & Nonstationary Media	
20	Nov 16 (Thu)	Fundamentals of Mass Transfer & Nonstationary Media	
21	Nov 21 (Tue)	Stationary Medium	Tutorial ends on Nov 24 (Thu).
22	Nov 23 (Thu)	Stationary Medium / Homogeneous Chemical Reaction and Unsteady-State	**HW2 release**
23	Nov 28 (Tue)	Homogeneous Chemical Reaction and Unsteady-State	
24	Nov 30 (Thu)	Review for final exam	Last quiz
	Dec 1–6	*Study Break*	
	Dec 7–19	***Final Exam***	

Due for HWs: One week after the release