Fall 2024 Syllabus
CHEN 3210 Heat & Mass Transfer

Instructors

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Please contact the Advanced TA with any questions about homework and its grading and solutions

Class Times and Information

In-person Lectures:	MW 8:30−10:20 am BIOT 108
Course Website:	https://canvas.colorado.edu/
Lecture Postings:	Lecture notes will be posted afterwards on the Canvas site.
Announcements:	Announcements concerning assignments, exams, clarification of course notes, etc. will be made on Canvas and/or by email. To ensure you receive announcements, please be sure to check or forward your colorado.edu email accordingly.

Office Hours (Help Sessions)

Tuesdays and Thursdays 3 – 5 pm in BIOT E1B11 (no Th OH on midterm weeks), Wednesdays 10:30 – 11:45 am in BIOT E1B11
Professors Davis (11 am – 12 pm most Wednesdays) and Sprenger (11 am - 12 pm most Mondays) will hold non-homework, private office hours by appointment (signups via Google sheets shared on Canvas).

Textbook

Required: *Fundamentals of Momen., Heat and Mass Transfer. 7th Ed.* Welty, Rorrer & Foster, Wiley, 2019

Prerequisites

CHEN 3200 Chemical Engineering Fluid Mechanics, or equivalent (minimum grade C-)

Course Requirements and Grading Scheme

The breakdown of course grades is as follows:

Midterm Exams (two)	40%
Class questions (see Policies)	0%
Homework	20%
Quizzes	10%
Final Exam	30%

The grading scale is:

A (or A-)	85 – 100%
B (or B-, B+)	75 – 85%
C (or C-, C+)	65 – 75%
D (or D-, D+)	55 – 65%
F	0 – 55%

Course Policies

Homework. Homework assignments will normally be posted on the course website at least one week in advance and *due via Gradescope at 11:59 pm* on Thursdays, unless notified otherwise. Solution sets must be turned in individually and not be copied from another person or source, although you are encouraged to consult your classmates as needed. Homework loaded on Gradescope 10 – 60 min late will be marked down 10%; homework loaded on Gradescope 61 – 120 min late will be marked down 20%. Later homework will not be accepted, except for special circumstances such as cases of illness or approved travel, in which case the student should contact one of the instructors before 6 pm on the due date to make alternative arrangements (usually an extension can be granted until 4 pm that Saturday). The lowest homework score will be dropped, accounting for both excused and unexcused absences. There will be no homework due during Thanksgiving week, midterm weeks, and one other week.

Quizzes/Participation. There will be four quizzes done remotely on 9/16/24, 9/30/24, 11/04/24, and 12/04/24; these quizzes may be done individually or in small groups. The quizzes will assess your knowledge of material covered in homework and lectures, and they will help prepare you for the midterms and final exams. There will also be short, clicker-type participation questions done during class time (and only by students attending class) on most days. These questions will not be a weighted component of the course grade, but an incentive is provided for them: If a student's % score on the final exam is greater than their average % score on the midterms, then a bonus of 10% multiplied by the fraction of participation questions done correctly will be added to the combined midterm score, with a maximum of the midterm % score equaling the % score of the final exam.

Exams. There will be two midterms and a final (dates below). Note that the final exam will be cumulative and thus serve as a gauge of your overall understanding of the course material. Missed exams can be made up in extreme cases only, including, among others, illness that requires medical attention, University-related approved travel, or death of a family member. If you know you will miss an exam, please contact an instructor *in advance* for your options to make up the exam.

Classroom and Behavior. It is requested that students make every effort to arrive on-time to class, such that class can be started as scheduled without interruption, and that safe and professional behavior be exhibited at all times. Also, *any discovered incidents of academic dishonesty will be reported* to the CU Honor Code Council. Consequences will include receiving a failing grade in the course.

The instructors, assistants and students in this course affirm the value of all individuals and agree to treat one another with equity and respect. Please see the college webpage for our commitment to diversity, equity and inclusion: https://www.colorado.edu/engineering/about/diversity-equity-and-inclusion.

Policies on Missing and Late Assignments: Please review separate document posted on Canvas

Exam Dates

Midterm Exam #1:	Wednesday 10/02/2024, 7 - 9 pm, BIOT A104, A108, B115
Midterm Exam #2:	Wednesday 11/13/2024, 7 - 9 pm, BIOT A104, A108, B115
Final Exam:	Monday 12/16/2024, 7:30 – 10 pm, BIOT A108 + TBD

Required Syllabus Statements: Please visit https://www.colorado.edu/academicaffairs/policies-customs-guidelines/required-syllabus-statements

LearnChemE Videos: There are many short videos/screen casts on heat and mass transfer created for LearnChemE, which originated in our department and now used world-wide. The following link is to heat-transfer screencasts: www.learncheme.com/screencasts/heat-transfer. We also created screencasts with embedded quiz questions for our heat-transfer intensive course: www.learncheme.com/screencasts/heat-transfer/heat-transfer-quiz-screencasts and for mass transfer (see Canvas site). Students are encouraged to use these supplemental materials to reinforce the concepts of this course.

Course Purpose and Goals

The purpose of this course is for students to gain understanding and knowledge of the transfer of thermal energy (“heat”) and molecular species (“mass”) from one location to another. This knowledge will allow students to analyze and design processes to accomplish desired heat and mass transfer in engineering applications. Specific learning goals include:

1. Heat Transfer

- Knowledge of the three primary modes of heat transfer: conduction, convection and radiation
- Ability to perform microscopic and macroscopic thermal energy balances for various situations
- Ability to solve 1D-steady heat conduction problems in flat, cylindrical and spherical geometries, and 2D steady and 1D-transient heat conduction problems in flat geometries
- Understanding of boundary-layer flow and heat transfer
- Knowledge and use of scaling and order-of-magnitude analysis for conduction and convection
- Ability to use heat-transfer correlations for forced and free convection
- Understanding of heat radiation and the ability to determine radiation exchange for black and gray surfaces
- Ability to apply resistance models for insulation design and energy balances for heating or cooling rates of objects
- Ability to analyze and design single-tube, double-tube, and crossflow or shell-and-tube heat exchanges, with and without phase change

2. Mass Transfer

- Knowledge of the two primary modes of mass transfer: diffusion and convection
- Ability to perform species mass balance and flux calculations for various situations
- Ability to solve 1D steady and unsteady diffusion problems, with and without chemical reaction
- Understanding of boundary-layer mass transfer, and scaling and order-of-magnitude analysis of diffusion and convection
- Ability to use mass-transfer correlations for forced convection
- Understanding of mass transfer between phases and ability to analyze two-phase mass-transfer problems

Lecture Schedule for CHEN 3210 – Fall 2024

Note: The lectures are given on Mondays and Wednesdays during 8:30-10:20 am, with a short break.

Day	Date	Lect. No.	Instructor	Topic (Chapter in Text)
M	**8/26**	**1a, b**	**RD, KS**	Introduction, Heat Conduction Basics (15,16)
W	**8/28**	**2a, b**	**KS**	Steady, 1D Conduction: Flat Walls (17)
M	**9/2**	**----**	**----**	No Class (Labor Day)
W	**9/4**	**3a, b**	**KS**	Steady, 1D Conduction: Curved Walls (17)
M	**9/9**	**4a, b**	**KS**	Steady Conduction with Generation (17)
W	**9/11**	**5a, b**	**KS**	Extended Surfaces; Steady, 2D & 3D Conduction (17)
M	9/16	6a, b	RD	Transient Heat Conduction & Scaling (16,18)
W	9/18	7a, b	RD	Transient Example; Introduction to Convection (19)
M	9/23	8a, b	RD	Thermal Energy Equation; Dimensional Analysis (16,19)
W	9/25	9a, b	RD	Forced Convection; Boundary-layer Flow & HT (19)
M	9/30	10a, b	KS	Heat-transfer Correlations (19,20); Review for MT #1
W	10/2	11a, b	RC, RD	Examples using HT Correlations; Free Convection (20)
M	10/7	12a, b	KS	Discussion of MT #1; Free Convection & Correlations (20)
W	10/9	13a, b	KS	Introduction to Radiation; Emission of Radiation (23)
M	**10/14**	**14a, b**	**KS**	Radiation Exchange Between Surfaces (23)
W	10/16	15a, b	RD	Heat-transfer Design; Insulation (15,17,20,23)
M	10/21	16a, b	RD	Transient Cooling; Single-tube Heat Exchangers (18,22)
W	10/23	17a, b	KS	Double-tube Heat Exchangers & Examples (22)
M	10/28	----	----	No Class (AIChE Meeting)
W	10/30	18a, b	KS	Phase Change; Shell-and-Tube Heat Exchangers (21,22)
M	**11/4**	**19a, b**	**KS**	NTU Method for Heat Exchangers & Examples (22)
W	11/6	20a, b	RD	Intro to Mass Transfer & Flux Eq (24); Random Motion/Diff.
M	11/11	21a, b	RD	Review for MT #2; Convection-diffusion Equation (24,25)
W	11/13	22a, **b**	KS	Conv-Diff Eq. Approach & Examples: Equimolar Diff. (25)
M	11/18	23a, b	KS	Steady & Pseudo-steady Diffusion and Reaction (26)
W	11/20	24a, b	RC, RD	Numerical Methods; Ethics, Communications & Leadership
M	11/25	----	----	No Class (Fall Break)
W	11/27	----	----	No Class (Fall Break)
M	12/2	25a, b	RD	Unsteady Diffusion with & without Reaction (26,28)
W	12/4	26a, b	RD	Evaporation; Forced Convection (26, 28)
M	12/9	27a, b	RD	Mass-transfer Correlations; Adsorption (30)
W	12/11	28a, b	RD	Mass-transfer Between Phases; Absorption (30)

RD = Robert Davis, KS = Kayla Sprenger, RC = Raj Chattopadhyay

Midterms: 7 – 9 pm on W 10/2 and W 11/13 in A108, A104, and B115
Final Exam: 7:30 – 10 pm on M 12/16 in A108 & TBD
Review for Final Exam: 1:00 – 2:15 pm on F 12/13 in A108