Fall 2024

CHE 370-001: Heat and Mass Transfer

Donald Sebastian

ChE370 – Heat and Mass Transfer
Fall 2024
Otto H. York Department of Chemical & Materials Engineering
New Jersey Institute of Technology

Course Schedule: T 10:00 AM – 12:00PM R 11:30 AM – 1:30PM
Office Hours: T 12:00PM – 1:00PM R 1:30 AM – 2:30PM, in-person or WEBEX other times by request
Instructor: Dr. Donald H. Sebastian, Professor
Instructor Contact: Tiernan 387, (973)642-4465, sebastia@njit.edu
Instructor Webpage: https://people.njit.edu/faculty/sebastia

Teaching Assistant: TBD
TA Contact: -

Catalog Description:
CHE 370 - HEAT AND MASS TRANSFER (4 credits). The principles of heat and mass transfer in chemical engineering systems are covered. Steady and unsteady heat transfer is examined, with emphasis on the heat exchanger design. Mass transfer by steady and unsteady molecular diffusion, and turbulent convective mass transfer is studied.

Pre-requisites: Prerequisites: ChE 240, ChE 260, Math 222.

Course Objectives:

1. To develop the students' skills in applying differential equations and numerical techniques or describing steady and transient heat and mass transfer problems
2. To develop the students' skills in using the solution to problems in heat and mass transfer components and systems to make design decisions for chemical engineering unit processes
3. To provide the students with fundamental theoretical concepts and practical analysis skills associated with convective heat and mass transfer including external and internal flow configurations
4. To provide the students with fundamental theoretical concepts and practical analysis skills associated with radiation heat transfer
5. To develop students' skills in solving practical problems in integrated heat, mass and momentum transfer
6. To develop the students' skills in modeling and dimensionless analysis for heat and mass transfer problems in different geometries

Textbooks: Required – Heat and Mass Transfer for Chemical Engineers – Principles and Applications, Giorgio Carta, McGraw Hill (2021). ISBN: 978-1-264-26667-8

Recommended – 1) Fundamentals of Momentum, Heat and Mass Transfer– November 12, 2007

by James Welty, Charles E. Wicks, and Gregory L. Rorrer. ISBN-13: 978-0470128688, ISBN-10: 0470128682 Edition: 5th. 2) Transport Processes and Separation Process Principles. Christie John Geankoplis. ISBN-13: 978-0131013674 ISBN-10: 013101367X Edition: 4th. 3) Transport Phenomena, Revised 2nd Edition by R. Byron Bird, Warren E. Stewart, Edwin N. Lightfoot. ISBN-13: 978-0470115398 ISBN-10: 0470115394 4) Heat and Mass Transfer: Fundamentals and Applications–by Yunus Cengel and Afshin Ghajar. ISBN-13: 9780073398198, ISBN-10: 0073398195 Edition: 6th.

There are several editions of these texts that have been used for many decades and full text PDFs can be easily found on line – I have included some copies on the Canvas Course Modules.

Required Software: Latest versions of MATLAB, MS Office, Adobe Reader (all can be downloaded from NJIT IST webpage). Student Mall labs and ChE department PC lab have most of the software. The course will rely heavily on the use of the Symbolic Toolbox that is part of MATLAB. The Partial Differential Equation Toolbox Toolbox will also be used, and these should be added to your installation and MATLAB updated to the newest release. If you are not familiar with using MATLAB or these toolboxes, Mathworks has excellent on-lie tutorials:

MATLAB ONRAMP: https://matlabacademy.mathworks.com/details/matlab-onramp/gettingstarted
MATLAB FUNDAMENTALS: https://www.mathworks.com/learn/training/matlab-fundamentals.html
INTRODUCTION TO SYMBOLIC MATH WITH MATLAB:
https://matlabacademy.mathworks.com/details/introduction-to-symbolic-math-with-matlab/symbolic
SOLVING ORDINARY DIFFERENTIAL EQUATIONS WITH MATLAB:
https://matlabacademy.mathworks.com/details/solving-ordinary-differential-equations-with-matlab/odes
SOLVING NONLINEAR EQUATIONS WITH MATLAB:
https://matlabacademy.mathworks.com/details/solving-nonlinear-equations-with-matlab/rootfinding

Grading (curved at the end of the course as needed):
PARTICIPATION* – 5%
HOMEWORK– 15%
EXAMS – 30%
PROJECTS — 50%

*This course will implement an "active learning" environment. Therefore a significant portion of the grade will depend on interaction during class.

Homework and exams will be assigned through Canvas: https://canvas.njit.edu/ – Please check this site and your email often. Most of the homework, quizzes and solutions will be on this site, as well important course announcements. Homework is a necessary part of building your skills in problem solving. Given the ubiquity of solution manuals available on line, homework will not be graded, but will be checked for completeness and original work.

There may be a gray area between each two letter grades in the final distribution, so that two students getting similar weighted average, at the border of grade categories, could get different letter grades. If you are in one of these gray areas, whether you get the higher or lower grade depends on whether your performance has been improving or declining over the course period and on your overall class participation (attendance/discussion etc.).

Important University Dates (Add/Drop/Refund/Last Day to Withdraw/Recess/Finals):
http://www.njit.edu/registrar/calendars/
http://www.njit.edu/registrar/exams/finalexams.php

Sep 9	Last Day for 100% Refund, Full or Partial Withdrawal
Sep 16	Last Day for 90% Refund, Full or Partial Withdrawal
Sep 30	Last Day for 50% Refund, Full Withdrawal
Oct 21	Last Day for 25% Refund, Full Withdrawal
Nov 11	Last Day to Withdraw from Classes
Nov 26	Thursday Schedule (on Tuesday)
Dec 10	Last Class

Make-up sessions — If classes are cancelled due to inclement weather, we will ty to offer the class by distance learning technology. Announcements and links to the online session will be posted on Canvas.

Class Attendance: Experience shows that students who do not regularly attend class typically perform poorly in the course. There will be material and techniques discussed that are not in the textbook. In addition, examples are worked out during the lectures. These examples are may not be posted online. Students are responsible for all material covered in class.

Office Hours: This time is for you to come and seek help in case you don't understand the material, have an English problem, or are concerned about your grade. Coming to office hours shows that you care about learning and positively affects both your performance and evaluation. However, personal video-conferences can be arranged by request to suit the students need for help outside of the posted office hours.

Extenuating Circumstance & Other Situations: When a student invokes extenuating circumstances for any reason (late withdrawal from a course, request for a make-up exam, request for an Incomplete grade, request for accommodation due to illness) the student should be referred to the Dean of Students Office. The Dean of Students will make the determination of whether extenuating circumstances exist and will notify the instructor accordingly. Instructors should never request or accept medical or other documents from students; all documents should be submitted by the student to the Dean of Students Office. Except for cases determined by law, an instructor is not required to accommodate student requests even when extenuating circumstances are certified by the Dean of Students; however, all efforts should be made to ensure a student-friendly environment.

Online Synchronous Delivery: In the event that class cannot meet face-to-face, the class will meet via video conferencing (e.g., Webex, Zoom, MS-Teams, or similar) software. Students must keep their webcams ON at all times. NO audio or video recording is allowed. Nonoffending virtual backgrounds are allowed to maintain privacy. The use of offending backgrounds is not allowed and will be punished.

Class Recordings: Class sessions may be recorded by the instructor. These recordings shall only be used as an educational resource and are not to be distributed or used outside of this class. Links to recordings will be accessible from a Page in Canvas. Any recordings that contain identifiable information about students will not be used beyond this semester.

Class Recording Etiquette: Students are expected to respect their fellow students' privacy and freedom to learn without disruption. Students are not allowed to capture or reproduce anyone's name, image, or voice without permission. They must be polite and respectful in the online chat. Informal chat is okay, but typing is restricted to things that one would say out loud in front of the entire class. Students must

always conduct themselves on their webcam video as they would in person in a classroom.

COVID-19 Protocols: NJIT students, faculty and staff are required to receive a COVID-19 vaccination or request and receive approval for an exemption. Documentation of vaccination should be uploaded at njit.medicatconnect.com/home.aspx as soon as possible. Furthermore, effective on August 2nd, NJIT will require masks to be worn in all indoor public and common areas regardless of vaccination status, subject to exceptions that have previously existed, such as when employees are at separated workstations or private offices or when eating or drinking. Consequently, all students must be masked to attend the lecture. If they refuse, campus security will be called to remove them from the classroom.

Seating Chart: The instructor reserves the right to assign seating during the class lecture. If COVID-19 protocols demand it, socially distance seating will be enforces.

NJIT Honor Code: The NJIT honor code is being upheld on all issues related to the course. Students are expected to be familiar with the code and conduct themselves accordingly. Any violations will be brought to the immediate attention of the Dean of Students.

Academic integrity: Academic Integrity is the cornerstone of higher education and is central to the ideals of this course and the university. Cheating is strictly prohibited and devalues the degree that you are working on. As a member of the NJIT community, it is your responsibility to protect your educational investment by knowing and following the academic code of integrity policy that is found at: http://www5.njit.edu/policies/sites/policies/files/academic-integrity-code.pdf.

Please note that it is my professional obligation and responsibility to report any academic misconduct to the Dean of Students Office. Any student found in violation of the code by cheating, plagiarizing or using any online software inappropriately will result in disciplinary action. This may include a failing grade of F, and/or suspension or dismissal from the university. If you have any questions about the code of Academic Integrity, please contact the Dean of Students Office at dos@njit.edu.

***PRELIMINARY* SCHEDULE OF TOPICS TO BE ADJUSTED FOR STUDENT COMPREHENSION:**

Lecture	Date	Topic
PART I HEAT TRANSFER		
1	9/3/2024	CLASS OVERIEW, HISTORY OF CHEMICAL ENGINEERING
2	9/5/2024	BASIC CONCEPTS & HEAT TRANSFER EQUIPMENT
3	9/10/2024	CONDUCTIVE HEAT TRANSFER SHELL BALANCES
4	9/12/2024	CONDUCTIVE HEAT TRANSFER SHELL BALANCES IN CURVILINER COORDINATES
5	9/17/2024	CONVECTIVE HEAT TRANSFER
6	9/19/2024	COMPOSITE WALLS
7	9/624/2024	THERMAL NETWORKS
8	9/26/2024	SHAPE FACTORS
9	10/1/2024	EXAM PREP
10	**10/3/2024**	**EXAM-1 15%**
11	10/8/2024	EXAM 1 SOLUTION & RADIATION
12	10/10/2024	HEAT TRANSFER WITH THERMAL SOURCES
13	10/15/2024	HEAT TRANSFER WITH ADVECTION
14	10/17/2024	EXTENDED AREA HEAT TRANSFER
15	10/22/2024	HEAT EXCHANGER DESIGN

16	10/24/2024	HEAT EXCHANGER DESIGN II & FORCED CONVECTION HEAT TRANSFER
17	10/29/2024	INTERNAL & EXTERNAL FORCED CONVECTION HEAT TRANSFER
18	10/31/2024	SIMILARITY AND SCALING
19	11/5/2024	HEAT TRANSFER GENERALIZED THERMAL ENERGY BALANCE EQUATIONS
PART II MASS TRANSFER		
20	11/7/2024	TRANSIENT CONDUCTION IN SOLIDS
21	11/12/2024	MASS TRANSFER INTRODUCTION & MULTICOMPONENT EQUATIONS OF CHANGE **PROJECT 1 25%**
22	11/14/2024	DIFFUSIVE MASS TRANSFER
23	11/19/2024	CONVECTIVE MASS TRANSFER & MASS TRANSFER ANALOGIES
24	11/21/2024	MASS TRANSFER WITH HOMOGEOUS REACTION
25	11/26/2024	MASS TRANSFER WITH HETEROGEOUS REACTION
26	12/3/2024	EXAM PREP
27	12/5/2024	**EXAM-2 15%**
28	12/10/2024	EXAM 2 RESULTS & COURSE SUMMARY
	12/??/2024	**PROJECT 2 DUE ON DATE OF FINAL EXAM 25%**

Policies and Expectations about Exams/Grades

- The course letter grade will be assigned and **rounded** automatically by Excel (no emotions attached). The assigned letter grade is FINAL without subject to negotiation!
- Any excuses used to drop missed assignments or exams must first be documented with the Dean of Students. Instructor will NOT change letter grades to accommodate any special circumstances (unless excused by the Dean of Students). The student will get the letter grade they earn.
- Students must plan, study and do well in exams/projects if they want to get a good grade in this class. For every hour of lecture, at least an hour of out-of-class work is expected.
- Students may dispute the assignment and exam scores within a week following the announcement of the score. Students **cannot** dispute their prior exams or assignments after one week or at the end of the semester! Furthermore, upon requesting grade review the student accepts the possibility of instructor both **removing points**, as well as giving points, in case grading mistakes are found.
- Student handwriting must be legible in order to receive points.
- Students will get 0 for not showing up to quizzes, laboratory, exams, or any other course activity. If a student misses an exam due to extreme circumstances (such as a medical problem or a death in the family), they need to notify the instructor via email **before** the beginning of the exam and provide proof of the circumstance to the Dean of Student's office. Only in this case of official approval from the Dean of Student's office, may a make-up be given. When a student invokes extenuating circumstances for any reason (late withdrawal from a course, request for a make-up exam, request for an Incomplete grade) the student will be sent to the Dean of Students Office. The Dean of Students will be making the determination of whether extenuating circumstances exist or not and will be notifying the instructor accordingly. Instructors will never request or accept medical or other documents from students; such documents need to be submitted by the student to the Dean of Students. Except for cases determined by law, an instructor is not required to accommodate student requests even when extenuating circumstances are certified by the Dean of Students; however, all efforts should be made to ensure a student-friendly environment.
- Extra credit may be assigned during the semester, at the discretion of the instructor. There will be no make-ups, extra credit, or any additional projects/assignments given beyond the semester's completion.

- If an exam is open book; a single page of notes provided by the instructor may be permitted. These may be annotated by hand-writ. It cannot contain computer code, or homework solutions.
- When writing code, you may not “simplify” your assignment if all of your input data happens to fall within a single case scenario. Your code should be general enough to handle ALL possible input.
- During laboratory exercises, students may not communicate with anyone outside of their group.
- If multiple students **in a team exercise** turn in identical (or very similar) code/assignment/exam, a single gradewill be SHARED between those students. Otherwise the matter will be considered a violation of the Honor Code, and referred tothe Dean of Students Office.
- If you need accommodations due to a disability please contact the Associate Director of Disability Support Services, Fenster Hall Room 260 to discuss your specific needs. A Letter of Accommodation Eligibility from the Disability Support Services office authorizing your accommodations will be required.

Most important: Open your minds and have lots of fun!