

Fall 2021

## **CHE 370-001: Heat and Mass Transfer**

Donald Sebastian

Follow this and additional works at: <https://digitalcommons.njit.edu/cme-syllabi>

---

### **Recommended Citation**

Sebastian, Donald, "CHE 370-001: Heat and Mass Transfer" (2021). *Chemical and Materials Engineering Syllabi*. 207.

<https://digitalcommons.njit.edu/cme-syllabi/207>

This Syllabus is brought to you for free and open access by the NJIT Syllabi at Digital Commons @ NJIT. It has been accepted for inclusion in Chemical and Materials Engineering Syllabi by an authorized administrator of Digital Commons @ NJIT. For more information, please contact [digitalcommons@njit.edu](mailto:digitalcommons@njit.edu).

**ChE370 – Heat and Mass Transfer**  
**Fall 2021**  
**Otto H. York Department of Chemical, Biological & Pharmaceutical Engineering**  
**New Jersey Institute of Technology**

**Course Schedule:** TR 4PM – 5:50PM

**Office Hours:** TR 3PM – 4PM and other times strictly by appointment (e-mail)

**Instructor:** Dr. Donald H. Sebastian, Professor

**Instructor Contact:** Tiernan Hall 387, 1.973.642.4465, [sebastia@njit.edu](mailto:sebastia@njit.edu)

Note, please avoid sending internal messages through 3<sup>rd</sup> party platforms like Moodle or Canvas.

**Instructor Webpage:** <https://people.njit.edu/faculty/sebastia>

**Teaching Assistant:** Mr. Christopher Kossor

**TA Contact:** [cgk6@njit.edu](mailto:cgk6@njit.edu)

**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: Fundamentals and Applications–by Yunus Cengel and Afshin Ghajar. ISBN-13: 9780073398198, ISBN-10: 0073398195 Edition: 6<sup>th</sup>.

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: 5<sup>th</sup>. 2) Transport Processes and Separation Process Principles. Christie John Geankoplis. ISBN-13: 978-0131013674 ISBN-10: 013101367X Edition: 4<sup>th</sup>. 3) Transport Phenomena, Revised 2nd Edition by R. Byron Bird, Warren E. Stewart, Edwin N. Lightfoot. ISBN-13: 978-0470115398 ISBN-10: 0470115394 There are several editions of these texts that have been used for many decades and full text PDFs can be easily found on line.

**Required Software:** Latest versions of Matlab, MS Office, Endnote, Adobe Reader (all can be downloaded from NJIT IST webpage). Student Mall labs and ChE department PC lab have most of the software. Please see Highlander Pipeline for Matlab tutorial and example programs.

Grading (curved at the end of the course):

PARTICIPATION\* – 20%

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.

Grade Cut-offs

Percent	Grades
Above 85%	A
Above 80%	B+
Above 75%	B
Above 70%	C+
Above 65%	C
Above 55%	D
Equal or Below 55%	F

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 may 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>

Make-up sessions — If classes are cancelled due to inclement weather, we will try to offer the class by distance learning technology.

**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 text book. 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.

**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](http://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.

**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.

**Cell phones and other electronic devices:** must be turned off during both lectures and exams, unless specifically permitted by the instructor. For example, the use of personal computers or tablet devices for attending the video conferencing lectures is allowed.

**Office Hours Attendance:** 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.

**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 enforced.

**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](mailto:dos@njit.edu).

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

Lecture	Date	Topic
<b>PART I HEAT TRANSFER</b>		
1	9/02/2020	Class Overview, INTRODUCTION AND CURRICULAR ROADMAP
2	9/07/2020	Chapter 1: BASIC CONCEPTS & HEAT TRANSFER EQUIPMENT
3	9/09/2020	Chapter 2: HEAT CONDUCTION SHELL BALANCES
4	9/14/2020	Chapter 2: THERMAL ENERGY EQUATIONS OF CHANGE
5	9/16/2020	Chapter 3: STEADY HEAT CONDUCTION
6	9/21/2020	Chapter 3: STEADY HEAT CONDUCTION
	<b>9/23/2020</b>	<b>EXAM-1 15%</b>
7	9/28/2020	Chapter 4: TRANSIENT HEAT CONDUCTION
8	9/30/2020	Chapter 4: TRANSIENT HEAT CONDUCTION
9	10/05/2020	Chapter 6: FUNDAMENTALS OF CONVECTION
10	10/07/2020	Chapter 7: EXTERNAL FORCED CONVECTION
11	10/12/2020	Chapter 8: INTERNAL FORCED CONVECTION
12	10/14/2020	Chapter 9: NATURAL CONVECTION
	<b>10/19/2020</b>	<b>MIDTERM PROJECT 25%</b>
<b>PART II MASS TRANSFER</b>		
13	10/21/2020	Chapter 10: HEAT TRANSFER WITH PHASE CHANGE
14	10/26/2020	Chapter 13: RADIATIVE HEAT TRANSFER
15	10/28/2020	Chapter 14: BASIC CONCEPTS & MASS TRANSFER EQUIPMENT
16	11/2/2020	Chapter 14: CONDUCTIVE MASS TRANSFER SHELL BALANCES
17	11/4/2020	Chapter 14: MULTICOMPONENT EQUATIONS OF CHANGE
18	11/9/2020	CONVECTIVE MASS TRANSFER
	<b>11/11/2020</b>	<b>EXAM-2 15%</b>
19	11/16/2020	MASS TRANSFER WITH HOMOGENEOUS REACTION
20	11/18/2020	MASS TRANSFER WITH HETEROGENEOUS REACTION
21	11/23/2020	NON ISOTHERMAL MASS TRANSFER
	<b>11/25/2020</b>	<b>BREAK, NO CLASS</b>
22	11/30/2020	MACROSCOPIC BALANCES
23	12/02/2020	UNIT OPERATIONS
24	12/7/2020	COURSE REVIEW
	<b>12/9/2020</b>	<b>FINAL PROJECT 25%</b>

**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.
- Students have to plan, study and do well in exams/projects if they want to get a good grade in this class. 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 deserve.

- Students can 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.
- The graded exams must be returned to the instructor within a week to be saved for the department course assessment initiative.
- 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 may be permitted. These must be hand-written (not typed or photocopied). 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 leave if finished early. Instead, they are to assume TA roles and walk around (without computers) to help their classmates complete the assignment.
- During laboratory exercises, students may not communicate with anyone outside of their group.
- Students may NOT seek help from someone outside of the class.
- Students may NOT use course materials from the previous semesters, unless such materials have been explicitly shared with them by the instructor.
- If multiple students **in a team exercise** turn in identical (or very similar) code/assignment/exam, a single grade will be SHARED between those students. Otherwise the matter will be considered a violation of the Honor Code, and referred to the 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.
- Proctoring will be done via a combination of artificial intelligence algorithms implemented via Respondus lockdown browser in Canvas and observation of the student by the instructor and his TA.

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