ME EN 3650 / CH EN 3453 Heat Transfer
Department of Mechanical Engineering
University of Utah
Summer 2021

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Office Hours: Monday: 3.15 pm – 4.15 pm
Wednesday: 3.15 pm – 4.15 pm
Thursday: 4.00 pm – 5.00 pm (TA office hour)
By appointment

Class Schedule: MoWe
1:45 pm – 3:15 pm

Class Type: Interactive Video Class (IVC): A fully digital class that uses same-time delivery using web video technology. The class has a scheduled meeting time. CANVAS serves as the class location, with learning materials and links to join the class video meetings.

Zoom:

Classes, Exams, and Instructor Office Hours
Meeting ID: 913 6495 9191
Passcode: SummerHeat
Link: https://utah.zoom.us/j/91364959191

TA Office Hours
Meeting ID: 958 223 3880
Passcode: 125334
Link: https://utah.zoom.us/j/9582233880

Textbook: T.L. Bergman, A.S. Lavine, F.P. Incropera and D.P. DeWitt, *Fundamentals of Heat and Mass Transfer*, 8th edition, John Wiley & Sons, 2017 (ISBN 9781119353881).

As a part of the course fees ($72.80), students already have access to the textbook through the Inclusive Access Program (https://www.campusstore.utah.edu/facultyinclusiveaccess/). You can access the textbook via the "**Bookshelf**" tab on CANVAS. The advantages of the Inclusive Access Program are: (1) Students have immediate access to the textbook on the first day of class; (2) It typically reduces the cost to students. Students have until May 28th to opt-out of the Inclusive Access Program. Students planning to opt-out should still buy/rent a copy of the textbook. Note that the 6th and 7th editions of the textbook will also work.

Course Summary: Basic mechanisms of heat transfer, law of conservation of energy, conduction, convection, radiation, heat exchangers.

Prerequisites: ME EN 2300 / ME EN 3610: Thermodynamics
ME EN 3700 / ME EN 3710: Fluid Mechanics
Mechanical Engineering Upper Division Status

Corequisite: MATH 3150: Partial Differential Equations for Engineers

Grading:

Final Composite Score:	
Homework	15%
Mid-term exam 1	25%
Mid-term exam 2	25%
Final exam	35%
	100%

Grading Scale:

93 – 100%:	A
90 – 92%:	A-
87 – 89%:	B+
83 – 86%:	B
80 – 82%:	B-
77 – 79%:	C+
73 – 76%:	C
70 – 72%:	C-
67 – 69%:	D+
63 – 66%:	D
60 – 62%:	D-
below 60%:	E

Final grading scale may be lowered by the instructor based on the overall class performance but will not be raised.

Exams: i) Two mid-term exams and a final exam are scheduled. The final exam will be comprehensive. The exams are open book, open notes.
ii) Students must take the exam at the scheduled time. In some rare circumstances, a student can be considered for a make-up exam. Students will be required to provide a valid explanation with proof for this consideration. Please notify the instructor as soon as possible if you are unable to take an exam at the scheduled time.

Homework: i) Homework problems will be assigned on a weekly basis (see schedule for due dates).
ii) All homework assignments will be equally weighted (20 points each). Submitting a complete solution to all problems, including the answer(s), ensures a minimum grade of 8 points out of 20. In a given homework assignment, only one problem (chosen by the TA) will be formally graded and will constitute the remaining 12 points.
iii) Homework must be submitted by 11:59 pm on Thursday of the given week.
iv) Every student will be allowed to submit one late homework up to two days after the original due date. Students are advised to use this benefit carefully as no further

late homework will be allowed. The late homework should be sent to the instructor directly through email.
v) Homework solutions will be made available on the CANVAS course site two days after the original due date.

Homework and Exam Submission:

i) Homework and exams must be submitted on Gradescope.
ii) See the step-by-step tutorial for submitting assignments on Gradescope: https://www.youtube.com/watch?v=KMPoby5g_nE&feature=youtu.be

Class Policies:

i) All work submitted for grading should represent your individual effort. Since engineering is a group activity, students are highly encouraged to help each other to learn the course material and to discuss the homework assignments. However, all homework submitted must be each student's personal work. Students submitting homework showing evidence of copying will receive zero credit.
ii) Teamwork is not allowed during the exams. Students submitting showing evidence of copying will receive zero credit.
iii) The use of online resources (e.g., Chegg) during the exams is strictly prohibited.
iv) Submitting work copied from others will be considered academic misconduct. Plagiarism of ideas or work as well as giving or receiving unauthorized information on examinations will be considered academic misconduct. All academic misconduct will be dealt with severely and may result in a course grade of E.
v) If cheating and plagiarism become an issue, the instructor will conduct oral examinations.
vi) During the lectures, students are expected and encouraged to ask questions and participate in discussions. However, it may happen that some individuals have different points of view. While such an interactive and animated environment is usually beneficial from a learning standpoint, any disrespectful behavior toward the instructor or a classmate will not be tolerated. Any student showing such disrespectful behavior will be asked to leave the classroom.

Class Attendance:

i) It is your decision whether or not to attend class.
ii) If you have a University athletic or academic activity or a business engagement, please contact the instructor before you leave to determine appropriate accommodations for the absence.
iii) If you are absent for any other reason, please contact your classmates for any pertinent material. Do not see the instructor for notes and handouts.

Class Website:

A CANVAS course website has been established. Syllabus, presentations, homework assignments, homework solutions, link to Zoom lectures, and other useful documentation will be posted on the course website.

COVID-19:

i) What we are going through is not normal. It affects all of us in multiple ways. We may need to improvise and adapt during the semester.
ii) For a number of reasons (stress, isolation, etc.), some students are trying to take shortcuts during the pandemic. Cheating is a bad decision. Engineers must maintain the highest levels of integrity at all times. In the end, cheaters get caught.
iii) My priority is to maintain a humane classroom environment. We will support each other, look for simple solutions, share resources, and communicate clearly. We cannot learn if we are not doing well, so please let me know if you are dealing with a situation that is affecting you and your academic performance.

Course Objectives:

At the end of this course, the student will:

1. Be knowledgeable of Fourier's law (formulation and application)
2. Be able to formulate typical one-dimensional heat transfer differential equations with internal sources; apply boundary conditions; non-dimensionalize; and integrate
3. Understand the concept of thermal resistance and be able to manipulate strings of resistances as they may apply in real problems
4. Be able to use one-dimensional transient conduction charts and analytical expressions in the solution of problems
5. Be able to identify transient problems for which the semi-infinite solution applies
6. Be able to recognize and treat the lumped capacitance limiting solution for transient conduction problems
7. Be able to formulate and solve conduction problems numerically. Included in this are: Transient and steady-state problems; one-, two-, and three-dimensional problems; and problems with a variety (e.g. insulated, constant temperature, specified heat flux, and convective) boundary conditions
8. Be able to recognize and solve conduction problems that are one-, two-, or three-dimensional, transient or steady-state, and with or without generation
9. Have a physical sense of the boundary layer concept. Understand, in an overview sense, the role of the boundary layer in convective heat transfer problems
10. Be able to apply appropriate design correlations for the variety of convective heat transfer problems
11. Be able to recognize problems involving heat exchangers, and be able to determine when the effectiveness-NTU and when the LMTD methods of analysis are called for. The student should be able to apply both of these methods in the solution of real problems
12. Be able to understand single-surface radiation concepts such as emission, irradiation, blackbody radiation, the effects of wavelength and direction, radiosity, emissivity, absorptivity, transmissivity, and reflectivity
13. Be able to understand the concept of view factor in radiative transfer and be able to calculate these quantities for a variety of geometries
14. Know how to apply the circuit analogy to the solution of gray-diffuse radiative exchange problems
15. Be able to recognize problems where combined heat transfer phenomena (e.g. radiation and convection) are important, and know how to treat simple examples of these combinations
16. Be able to perform energy balances on simple physical systems

Homework Guidelines:

Points to keep in mind as you prepare your homework:

1. Use brief comments to make your thinking clear, to connect parts of the problem, and to indicate where data and equations were obtained.
2. Be sure units are correct, consistent, and clearly stated.
3. Clearly identify the answer (box, arrow, etc.)
4. If more than 1 problem is on a page, separate with a double line.
5. Number pages in lower right-hand corner.

Americans with Disabilities Act of 1990:

The University of Utah seeks to provide equal access to its programs, services and activities for people with disabilities. If you will need accommodations in the class, reasonable prior notice needs to be given to the Center for Disability and Access (CDA), 162 Olpin Union Building, 581-5020 (V/TDD). CDA will work with you and the instructor to make arrangements for accommodations. All written information in this course can be made available in alternative format with prior notification to the CDA. Website: https://disability.utah.edu

ME EN 3650 / CH EN 3453 – Heat Transfer
Summer 2021 Schedule

Week	Class #	Date	Day	Topics	Sections to read in the textbook	HW due (Thursday)
1	1	May 17	M	Syllabus, Introduction, Rate Equations	1.1, 1.2	
	2	May 19	W	Rate Equations, Conservation of Energy	1.2 – 1.6	
2	3	May 24	M	Conduction Rate Equation, Thermal Properties, Heat Diffusion Equation	2.1 – 2.3	1
	4	May 26	W	Boundary and Initial Conditions, 1D Steady-State Conduction (Plane Wall)	2.4, 3.1	
3		May 31	M	**Memorial Day**		2
	5	June 2	W	1D Steady-State Conduction (Plane Wall), Alternative Conduction Analysis, Radial Systems	3.1-3.4	
4	6	June 7	M	Radial Systems, Conduction with Thermal Energy Generation, Extended Surfaces	3.3-3.6	3
	7	June 9	W	Extended Surfaces, 2D Steady-State Conduction (Introduction), Overview of Analytical Methods, Finite-Difference Equations	3.6, 4.1, 4.2, 4.4	
5	8	June 14	M	Finite-Difference Equations, Finite-Difference Solutions, Transient Conduction – Lumped Capacitance	4.4, 4.5, 5.1 – 5.3	4
	9	June 16	W	Transient Conduction – Lumped Capacitance, Transient Conduction – Spatial Effects	5.1 – 5.6	
6	10	June 21	M	**Mid-Term Exam 1 (Chapters 1 to 5)**		5
	11	June 23	W	Introduction to Convection, Boundary Layer Equations	6.1 – 6.5	
7	12	June 28	M	Dimensionless Parameters, Boundary Layer Analogies, External Flow (Introduction), Empirical Method	6.6, 6.7, 7.1	6
	13	June 30	W	Flat Plate in Parallel Flow	7.2, 7.3	
8		July 5	M	**Independence Day**		7
	14	July 7	W	Flat Plate in Parallel Flow, Cylinder and Sphere in Cross Flow, Hydrodynamic and Thermal Considerations (Internal Flow)	7.2-7.5,8.1,8.2	
9	15	July 12	M	Hydrodynamic and Thermal Considerations (Internal Flow), Energy Balance (Internal Flow)	8.1-8.3	8
	16	July 14	W	Energy Balance (Internal Flow), Flow in Circular and Noncircular Tubes	8.3-8.6	
10	17	July 19	M	**Mid-Term Exam 2 (Chapters 6-8)**		9
	18	July 21	W	Heat Exchanger Types, Overall Heat Transfer Coefficient, LMTD Method, NTU Method	11.1 – 11.4	
11	19	July 26	M	NTU Method, Design and Performance Calculations, Introduction to Thermal Radiation, Radiation Fluxes,	11.4,11.5, 12.1-12.2	10
	20	July 28	W	Radiation Intensity, Blackbody Radiation, Radiative Properties of Real Surfaces	12.3-12.6	
12	21	Aug. 2	M	Kirchhoff's law, Gray Surface, View Factors	12.7 – 12.9,13.1	
	22	Aug. 4	W	Blackbody Radiation Exchange	13.2	
	23	Aug. 5	Th	**Final Exam**	**12.30 PM – 2.30 PM**	

COLLEGE OF ENGINEERING GUIDELINES

https://www.coe.utah.edu/semester-guidelines **Summer Semester 2021**

Appeals Procedures

See the Code of Student Rights and Responsibilities, located in the Class Schedule or on the UofU Web site for more details

Appeals of Grades and other Academic Actions

If a student believes that an academic action is arbitrary or capricious he/she should discuss the action with the involved faculty member and attempt to resolve. If unable to resolve, the student may appeal the action in accordance with the following procedure:

1. Appeal to Department Chair (in writing) within 40 business days; chair must notify student of a decision within 15 days. If faculty member or student disagrees with decision, then,
2. Appeal to the Academic Appeals Committee (see coe.utah.edu/academics for members of committee). See II Section D, Code of Student Rights and Responsibilities for details on Academic Appeals Committee hearings.

Americans with Disabilities Act (ADA)

The University of Utah seeks to provide equal access to its programs, services, and activities for people with disabilities. If you need accommodations in a class, reasonable prior notice needs to be given to the instructor and to the Center for Disability Services, 162 Olpin Union, 581-5020 (V/TDD) to make arrangements for accommodations. All written information in a course can be made available in alternative format with prior notification to the Center for Disability Services.

Adding Classes-*Full Term*

Please read carefully: All classes must be added within **8 academic days** of the beginning of the semester (deadline: Wed. May 26, 2021). Late adds will be allowed May 27th - June 7th requiring only the instructor's signature. Any request to add a class after June 7th will require signatures from the instructor, department, and Dean, and need to be accompanied by a petition letter to the Dean's office.

A $50 FEE WILL BE ASSESSED BY THE OFFICE OF THE REGISTRAR FOR ADDING CLASSES AFTER THE JUNE 7th DEADLINE

******Before you elect to take a class CR/NC you should check with your Advisor. Core classes used to compute your Engineering GPA need letter grades.**

Withdrawal Procedures

See the Class Schedule or web for more details ** Please note the difference between the terms "drop" and "withdraw". Drop implies that the student will not be held financially responsible and a "W" will not be listed on the transcript. Withdraw means that a "W" will appear on the student's transcript and tuition will be charged. **

Drop Period For Full Term Classes– No Penalty

Students may DROP full term classes without penalty or permission during the FIRST EIGHT academic days of the term (Wednesday, May 26, 2021).

Withdrawal from Full Term Length Classes

Students may WITHDRAW from full term classes without petition through **Friday, June 25, 2021.** Beginning May 27, 2021 until June 25, 2021, a "W" will appear on the transcript AND **tuition will be charged**. Refer to Class Schedule, Tuition and Fees for tuition information.

Drop/Withdrawal from Session I & Session II

See the web page for details: registrar.utah.edu/academic-calendars/summer2021.php

Withdrawals for term length classes after June 25th will only be granted due to compelling, nonacademic emergencies. A petition and supporting documentation must be submitted to the Dean's Office. Please email coepetitions@utah.edu for more info. Petitions must be received before the last day of classes (**August 4, 2021**).

Repeating Courses

When a College of Engineering class is taken more than once, only the grade for the second attempt is counted. Grades of **W, I, or V** on the student's record count as having taken the class. Departments enforce these guidelines for other courses as well (e.g., math, physics biology, chemistry). Attempts of courses taken at transfer institutions count as one attempt. This means a student may take the course only one time at the University of Utah. Courses taken at the University of Utah may not be taken a second time at another institution. If a second attempt is needed, it must be at the University of Utah. Please work with your department advisor to determine the value of repeating courses. Students should note that anyone who takes a required class twice and does not have a satisfactory grade the second time may not be able to graduate. It is the responsibility of the student to work with the department of their major to determine how this policy applies in extenuating circumstances.

Important Safety Information

The University of Utah values the safety of all campus community members. To report suspicious activity or to request a courtesy escort, call campus police at 801-581-COPS (801-585-2677). You will receive important emergency alerts and safety messages regarding campus safety via text message. For more information regarding safety and to view available training resources, including helpful videos, visit https://safeu.utah.edu