THE UNIVERSITY OF UTAH

ME EN 3650 / CH EN 3453 Heat Transfer
Department of Mechanical Engineering
University of Utah
Spring 2013

Instructor: Prof. Mathieu Francoeur
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Office Hours: M,W,F 12:00 pm – 1:00 pm

Class Schedule: M,W,F
8:35 am – 9:25 am
WEB L105

Textbook: T.L. Bergman, A.S. Lavine, F.P. Incropera and D.P. DeWitt, *Fundamentals of Heat and Mass Transfer*, 7th edition, John Wiley & Sons, 2011 (ISBN 978-0470-50197-9).

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

Prerequisites: ME EN 2300: Thermodynamics I
ME EN 2450: Numerical Techniques in Engineering
ME EN 3700: Fluid Mechanics
Mechanical Engineering Upper Division Status

Corequisites: MATH 3150: Partial Differential Equations for Engineers
ME EN 3650: Heat Transfer Lab

Grading:

Final Composite Score Based On:	ME EN 3650	CH EN 3453
Mid-term exam 1	22%	25%
Mid-term exam 2	22%	25%
Final exam	31%	35%
Homework	10%	15%
ME EN 3650 Lab (6 experiments)	15%	N/A
	100%	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: Two mid-term exams and a final exam are scheduled. The final exam will be comprehensive. In the event of a missed exam, students will be required to provide a valid explanation for the conflict and will be required to complete a make-up exam. Please notify the instructor as soon as possible if you are unable to take an exam at the scheduled time.

Homework: i) Homework problems from the textbook will be assigned on a weekly basis (see schedule for due dates).
ii) All homework assignments, consisting of about 5 problems each, will be equally weighted (20 points each). Submitting a complete solution to all problems, including the answer(s), ensures a minimum grade of 12 points out of 20. In a given homework assignment, only 1 problem (chosen by the instructor) will be formally graded, and will constitute the remaining 8 points.
iii) Homework will be collected in class on the due date listed in the schedule. Alternatively, homework may be placed in the class basket in the ME office (MEB 2110).
iv) Homework must be turned in by 5:00 pm on the assignment due date to avoid a late penalty.
v) Late homework will be accepted up to 2 days following the original due date. The late penalty is 10% per day. This penalty will be assessed unless there are extenuating circumstances (i.e., documented illness). On a homework due date immediately preceding an exam, no late homework will be accepted in order that solutions may be made available following the class.
vi) Homework solutions will be made available on the CANVAS course site 2 days after the original due date.

Laboratory: Six experiments constitute the lab portion of the course. Reports will be required for each experiment. All reports for the lab section will be equally weighted. Details about the lab are provided in the ME EN 3650 Lab course syllabus.

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 and lab reports submitted must be each student's personal work. Students submitting work showing evidence of copying will receive zero credit.
ii) 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.
iii) Laptop computers may only be used to take notes. The use of cell phones is strictly prohibited in the classroom.
iv) 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: (i) A CANVAS course website has been established. Syllabus, PowerPoint presentations, homework assignments, homework solutions, lab assignments and other useful documentation will be posted at the course website.
(ii) Electronic communication with all students will be made using a class email list compiled by the registrar. CANVAS email will not be supported. If your email address listed with the registrar is out of date, please update it by accessing the Campus Information System (CIS).

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. Use only one side of the paper.
5. If more than 1 problem is on a page, separate with a double line.
6. Number pages in lower right hand corner.
7. Staple at upper left 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 Services, 162 Olpin Union Building, 581-5020 (V/TDD). CDS 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 Center for Disability Services.

ME EN 3650 / CH EN 3453 – Heat Transfer
Spring 2013 Schedule

Week	Class #	Date	Day	Topics	Sections to read in the book	HW due dates
1	1	Jan. 7	M	Introduction, Rate Equations	1.1, 1.2	
	2	Jan. 9	W	Conservation of Energy	1.3 – 1.7	
	3	Jan. 11	F	Introduction to Conduction	2.1 – 2.3	
2	4	Jan. 14	M	Diffusion Equation; Boundary Conditions	2.3 – 2.5	
	5	Jan. 16	W	1D Steady-State Conduction	3.1	1
	6	Jan. 18	F	Radial Systems	3.2 – 3.4	
3		Jan. 21	M	**Martin Luther King Jr. Day holiday**		
	7	Jan. 23	W	Conduction with Energy Generation	3.5	2
	8	Jan. 25	F	Extended Surfaces	3.6	
4	9	Jan. 28	M	2D Steady-State Conduction	4.1 – 4.3	
	10	Jan. 30	W	Finite-Difference Equations	4.4	3
	11	Feb. 1	F	Finite-Difference Solutions	4.5	
5	12	Feb. 4	M	Transient Conduction – Lumped Capacitance	5.1 – 5.3	
	13	Feb. 6	W	Spatial Effects	5.4 – 5.6	4
	14	Feb. 8	F	Semi-Infinite Solids and Other BCs	5.7, 5.8	
6	15	Feb. 11	M	Finite-Difference Methods	5.10	
	16	Feb. 13	W	Introduction to Convection	6.1 – 6.3	
	17	Feb. 15	F	*Review for Mid-Term Exam 1*		5*
7		Feb. 18	M	**President's Day holiday**		
	18	Feb. 20	W	**Mid-Term Exam 1 (Chapters 1 to 5)**		
	19	Feb. 22	F	Boundary Layer Equations	6.4, 6.5	
8	20	Feb. 25	M	Dimensionless Parameters; Analogies	6.6 – 6.8	
	21	Feb. 27	W	External Flow – Flat Plate	7.1, 7.2	6
	22	Mar. 1	F	Cylinder in Cross Flow	7.3, 7.4	
9	23	Mar. 4	M	Sphere, Examples, Summary	7.5, 7.9	
	24	Mar. 6	W	Internal Flow	8.1 – 8.3	7
	25	Mar. 8	F	Circular Tubes	8.4, 8.5	
10		Mar. 11	M	**Spring Break**		
		Mar. 13	W	**Spring Break**		
		Mar. 15	F	**Spring Break**		
11	26	Mar. 18	M	Correlations	8.6, 8.7	8
	27	Mar. 20	W	Introduction to Free Convection	9.1 – 9.4	
	28	Mar. 22	F	Free Convection Correlations	9.5 – 9.8	
12	29	Mar. 25	M	Heat Exchangers, U, LMTD	11.1 – 11.3	9
	30	Mar. 27	W	ε-NTU Method for Analysis	11.4	
	31	Mar. 29	F	ε-NTU Method for Design	11.5 – 11.7	
13	32	Apr. 1	M	*Review for Mid-Term Exam 2*		10*
	33	Apr. 3	W	**Mid-term exam 2 (Chapters 6-9, 11)**		
	34	Apr. 5	F	Introduction to Thermal Radiation	12.1 – 12.3	
14	35	Apr. 8	M	Blackbody Radiation and Emissivity	12.4, 12.5	
	36	Apr. 10	W	Surface Properties and Kirchhoff's law	12.6 – 12.10	
	37	Apr. 12	F	View Factors	13.1	
15	38	Apr. 15	M	Blackbody Radiation Exchange	13.2	
	39	Apr. 17	W	Radiation Exchange Gray Surfaces	13.3	11
	40	Apr. 19	F	Radiation Exchange Gray Surfaces	13.3	
16	41	Apr. 22	M	Multimode Heat Transfer	13.4	
	42	Apr. 24	W	*Review Final Exam*		12*
		Apr. 26	F	No class		
17	43	Apr. 30	T	**Final Exam**	**8:00 am – 10:00 am**	

*** no late homework accepted**