Division of Engineering and Mathematics
School of Science, Technology, Engineering, and Mathematics
University of Washington Bothell

B ME 333 Heat Transfer

Spring 2020

Time and Location: MW 1:15 - 3:15 pm online (Canvas)
Canvas Homepage: https://canvas.uw.edu/courses/1387638

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Office Hours: MW 3:15 - 4 pm on Zoom and by appointment

Overview

Heat Transfer covers the mechanisms of energy transfer as heat along with their application and control in various engineered systems. Principal topics include conduction, forced conviction in external and internal flow, free convection, radiation, heat exchangers, and compressible flow.

Learning Outcomes

1. Identify and explain the mechanisms of heat transfer.
2. Apply heat transfer theory and methods to solve engineering problems.
3. Analyze and design heat exchangers.
4. Design a thermal fluids system that incorporates heat transfer, fluid mechanics, and thermodynamics to meet a client specification.
5. Work virtually in a team, using online tools, to design a system and present the results.

ABET Learning Outcomes

Outcome (1): An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics (directly assessed).
Outcome (5): An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectivity.

Textbooks and References

The following textbook is required and should be ordered from the UW Bookstore (which promises free delivery to your home):

Theodore L. Bergman et al, *Fundamentals of Heat and Mass Transfer*, Eighth Edition (Seventh Edition ok), Wiley, 2019.

The textbook comes bundled with WileyPlus. Though not required, it may be a useful resource in helping develop skills at problem solving.

Another version of the textbook we've used in the past by the same author is *Introduction to Heat Transfer*, 6th Edition; it should work for this course too.

Other reading assigned at the end of the course will be posted in Canvas.

Since heat transfer is a major topic covered on the Fundamentals of Engineering (FE) Exam, I recommend that students consult the heat transfer section of the FE Reference Manual as a reference and become familiar with its conventions for representing variables and equations. This part of the handbook will be posted in Canvas.

Assignments and Grading

All assignments are submitted in Canvas and are open-book. Hand-written work should be done on green engineering paper, scanned at a reasonably high resolution (preferably in black and white, unless color is needed to distinguish parts of images, equations, or other content) and combined into a single pdf document.

Homework (20 %): Problem sets will be assigned regularly. Each set will be posted in Canvas approximately one week before it is due. You may hand-write or word-process solutions. Use the same homework format (Given, Find, Drawing, Assumptions, Properties, Solution) that was required in thermodynamics. Solutions will be posted after the homework has been collected. Homework is due at start of class (1:15).

Canvas Quizzes (10 %): Short quizzes in Canvas will be given during some class meetings. These quizzes, which are not announced in advance, will be based on that day's assigned reading or on a topic presented during the day's class session up until the time the quiz is given. These quizzes will open in Canvas at the appointed time, which may be at the start, middle, or end of a class session. Until that time, the quiz will not be visible. All questions will be multiple choice; they may be conceptual or require one or more calculations to arrive at the answer.

Two mid-term and one final exam (20 % each): Open book and notes, given as Canvas quizzes. All questions will be multiple choice. The longer problems will require that you upload your calculations in a pdf file. Partial credit may be given for the longer problems for the portion of work that is correct, even if the answer is wrong; little or no credit is given to correct guesses with missing or incorrect supporting calculations. You are required to sign a document I'll prepare for you to affirm that you followed the rules strictly and did not cheat. Exams must be completed by 3:15 pm; this means you will need to factor in time after answering the questions to scan your work, convert it to pdf, and upload it into Canvas. Late penalties will apply after 3:20, though these may be waived if technical difficulties delay submission and you explain the situation to me.

Project (10 %). Done in teams of 4, the project is an open-ended scenario requiring you to apply heat transfer methods to analyze a problem or propose a rough design that meets a given specification. Your deliverable is a report, formally written, that defines the problem, gives background and/or discusses relevant theory, describes your idea for a design or

approach to a solution, and details your proposed solution. The report, to be submitted in Canvas by the team leader, should be typed in 12-point font, double-spaced, and include relevant drawings and calculations (drawings and calculations can be done by hand or in SolidWorks or other software). Length may vary depending on the problem, but I've found that most reports have been 6-12 pages in length when all materials are included. Project options will be posted and teams formed in the second week.

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Grading: Exams, homework, and projects are graded on the 100-point scale. Canvas quizzes are scored based on the number of questions, with one point given for each correct answer. Grades are converted to the 4-point scale using the following linear conversion: ≥95=4.0, 94=3.9, 93=3.8, 92=3.7, 91=3.6, 90=3.5,…,85=3.0,…,80=2.5,…,65=1.0, 62=0.7 (lowest passing grade), ≤62=0.
In exceptional circumstances, grades may be curved using the appropriate statistical measure.
More information on the UW grading system can be found here:
http://www.washington.edu/students/gencat/front/Grading_Sys.html

Late work: Ten points will deducted for each day a homework or project is late, though no credit will be given after three days. Submissions between 1:15 and 11:59 pm on the due date will be considered one day late; between 11:59 pm on the due date and 11:59 pm the following day two days late, and so on. Missed quizzes cannot be made up. Missed exams can be made up only in exceptional circumstances at the discretion of the instructor.

Policies and Campus Resources

For questions related to Zoom, Canvas, and the online course experience for students, see https://www.uwb.edu/it/student-continuity

Access and Accommodations: It is the policy and practice of the University of Washington to create inclusive and accessible learning environments consistent with federal and state law. If you have already established accommodations with Disability Resources for Students (DRS), please activate your accommodations via myDRS so we can discuss how they will be implemented in this course: http://depts.washington.edu/uwdrs/

If you have not yet established services through DRS, but have a temporary health condition or permanent disability that requires accommodations (conditions include but not limited to; mental health, attention-related, learning, vision, hearing, physical or health impacts), contact DRS directly to set up an Access Plan. DRS facilitates the interactive process that establishes reasonable accommodations. Contact DRS at uwbdrs@uw.edu.
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For Veterans: UWB offers many resources for those who may need guidance or assistance. This includes the Vet Corp Navigator through the WDVA and Student Veterans Association (SVA). Please contact Veteran Services at 425.352.5307 or rosal@uw.edu.
For those needing URGENT support: Please call *The Suicide Prevention Hotline* 1.800.273.8255 or connect with the UWB CARE Team at https://www.uwb.edu/studentaffairs/care-team.

A complete list of policies and resources available to students can be found here:
http://www.uwb.edu/getattachment/stem/about/stem-policies/classroom-policies-stem-fc-1-12-17.pdf.

Schedule for Spring 2020

	Topic/ Activity	Reading	Assignment
3/31	Overview and Getting Used to Online Class		Ice-Breaking
4/1	Intro to Heat Transfer	Ch 1 (all)	
4/6	Conduction Rate Equation	Ch 2 (all)	
4/8	1D Steady-State Conduction I (plane wall)	Ch 3 (3.1.1 - 3.1.4)	PS 1
4/13	1D Steady-State Conduction II (cylinders & spheres, internal heat generation)	Ch 3 (3.3 - 3.5)	
4/15	1D Steady-State Conduction (fins and extended surfaces)	Ch 3 (3.6)	PS 2
4/20	2D and Transient Conduction (shape factors, lumped capacitance method)	Chs 4 & 5 (4.1 - 4.3, 5.1, 5.2, 5.4, 5.5)	
4/22	Intro to Convection	Ch 6 (6.1 - 6.6)	PS 3
4/27	**Exam 1 (covers Chs 1 - 5)**		Exam 1 (Canvas)
4/29	Convection in External Flow I (boundary layer equations, flat plate)	Ch 7 (7.1 - 7.3)	
5/4	Convection in External Flow II (flow over cylinders, spheres, and tubes)	Ch 7 (7.4 - 7.6)	PS 4
5/6	Convection in Internal Flow I (hydrodynamic and thermal boundary layers)	Ch 8 (8.1 - 8.3)	
5/11	Convection in Internal Flow II (laminar & turbulent flow in tubes and ducts)	Ch 8 (8.4 - 8.6)	PS 5
5/13	Heat Exchangers	Ch 11 (11.1 - 11.5)	
5/18	**Exam 2 (covers Ch 6 - 8)**		Exam 2 (Canvas)
5/25	Memorial Day - No online meeting!		
5/27	Free Convection	Ch 9 (9.1 - 9.6)	PS 6
6/1	Heat Transfer by Radiation	TBA	Project Report
6/3	Compressible Flow & Shock Waves	TBA	PS 7
6/10	**Final Exam (comprehensive)**		Final (Canvas)

Notes
1. All class meetings will be held online using Zoom and will start promptly at 1:15.
2. Most readings are in Bergman et al, *Fundamentals of Heat and Mass Transfer*.
3. "TBA" readings will most likely be my notes or a mix of readings from different sources that will be made available in Canvas.