Fall 2023

ME 407-001: Heat Transfer

Peter Balogh

Heat Transfer: ME407-001
Fall 2023

Instructor: Dr. Peter Balogh
Email: peter.e.balogh@njit.edu
Office: Mechanical Engineering Center (MEC) 324A

Lectures: Wednesday, Friday 1:00PM – 2:20PM, Faculty Memorial Hall Room 305

Office Hours: Tuesday and Thursday, 1:00PM - 2:00PM or by appointment

Required Textbook:

Fundamentals of Heat and Mass Transfer, 8th Edition
by Bergman, Lavine, Incropera, and DeWitt
Wiley, 2020

Prerequisites:

MATH 222 – Differential Equations
ME 304 – Fluid Mechanics
ME 311 – Thermodynamics

Course Description:

A study of the three fundamental modes of heat transfer: conduction, convection, and radiation. A physical interpretation of the many quantities and processes in heat transfer using numerical methods. Theory is applied to the analysis and design of heat exchangers and other applications. Where appropriate, computer simulation is used.

Course Policies:

1. Grading

   Total of 100 points:
   - Homework (10)
   - Tests (20)
   - Midterm (20)
   - Final Exam (30)
   - Project (20)

   Scale:

A:	90-100
B+:	85-89
B:	80-84
C+:	75-79
C:	70-74
D:	60-69
F:	0-59

2. Attendance and Lecture Notes
   - Attendance will not be graded. Lecture notes will be written on the board during class, and there will be no electronic version available (i.e. no powerpoint, etc.). ***Thus, it is extremely important that you attend every class and take good notes.*** While the lectures will be based on the sections/topics in your textbook as noted in the course schedule below, attending each class will go a long way towards doing well in this course and learning the material.

3. NJIT Canvas
   - https://njit.instructure.com/courses/25314
   - Log in and make sure your email address is correct, as all course notifications will be posted on Canvas
   - HW assignments, exam information, and general course announcements will be posted on Canvas

4. Homework
   - Assignments are due at the beginning of class.
   - Each problem must be worked through in a clear and logical manner with any assumptions clearly stated. **The final answer must be clearly denoted.**
   - Partial credit will be given to problems in which the final answer is incorrect, with the amount dictated by my perception of how well you understand the problem. Thus, when working through a problem, the more detail you provide the better. Not only does this make for a more thorough analysis, but it will give you the best chance at maximizing partial credit for incorrect answers.

5. Tests and Exams
   - There will be two tests, a midterm and a final exam (see schedule below)
   - All tests and exams will be closed books / closed notes, however I will allow a single hand-written formula sheet as follows:
     i. one-sided for tests
     ii. both sides for midterm and final exam
   - Failure to show up will result in zero points, and there are no make-ups. The only exceptions are for an officially documented excuse from the Dean of Students.

6. Project
    - After the midterm there will be a project assigned with teams comprised of 2-3 students, and you will pick your own teams. This will involve application of theory learned in the course with open-source computational heat transfer software to solve a real-world heat transfer problem.
    - Over the course of the project, each team will submit (see schedule below for tentative due dates):
        i. A planning report outlining items such as project abstract and overview, roles of team members, etc. work schedule
        ii. A progress report outlining items such as summary of work to-date, status with regard to project schedule, and any difficulties encountered and plan for overcoming them.
        iii. A final report
    - Specifics on the project and submission requirements will be provided after the midterm

7. 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”

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Tentative Course Schedule (Subject to Change)

Lecture			Topics Covered	Assignment Due
No.	Date			
1	Wed	9/6/23	Course Introduction Chapter 1: Introduction to Heat Transfer	
2	Fri	9/8/23	Chapter 1: Introduction to Heat Transfer	
3	Wed	9/13/23	Chapter 2: Introduction to Conduction Fourier's Law Diffusion equation	
4	Fri	9/15/23	Chapter 2: Introduction to Conduction Transient behavior	HW1
5	Wed	9/20/23	Chapter 3: 1D, Steady-State Conduction The plane wall Radial systems	
6	Fri	9/22/23	Chapter 3: 1D, Steady-State Conduction Radial systems Conduction w/ thermal energy generation	HW2
7	Wed	9/27/23	Chapter 3: 1D, Steady-State Conduction Fin analysis	
8	Fri	9/29/23	Chapter 3: 1D, Steady-State Conduction Fin analysis	HW3
-	Wed	10/4/23	**Test 1**	
9	Fri	10/6/23	Chapter 5: Transient Conduction The lumped capacitance method	
10	Wed	10/11/23	Chapter 5: Transient Conduction One term approximation	
11	Fri	10/13/23	Chapter 5: Transient Conduction The semi-infinite solid	HW4
12	Wed	10/18/23	Chapter 4: 2D, SS Conduction The Finite Difference Method	

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13	Fri	10/20/23	Finite Difference Method for 2D Transient Conduction Assign Computer Project	HW5
-	Wed	10/25/23	**Midterm**	
14	Fri	10/27/23	Chapter 6: Introduction to Convection Dimensionless parameters Reynolds analogy	
15	Wed	11/1/23	Chapter 6: Introduction to Convection Dimensionless Parameters in the BL Reynold's Analogy	
16	Fri	11/3/23	Chapter 7: External flow Flat plate in parallel flow Cylinder in cross flow The sphere	HW6
17	Wed	11/8/23	Chapter 8: Internal flow Developing and Fully Developed Mean Temperature	Project Planning Report
18	Fri	11/10/23	Chapter 8: Internal flow Heat transfer correlations Entry length effects	HW7
-	Wed	11/15/23	**Test 2**	
19	Fri	11/17/23	Chapter 9: Free convection Laminar boundary layer Boussinesq approximation Similarity considerations	
20	Wed	11/22/23	Chapter 10: Pool boiling Film boiling Film condensation	Project Progress Report
-	Fri	11/24/23	**No Class - Thanksgiving Break**	
21	Wed	11/29/23	Chapter 11: Heat Exchangers Parallel and counter flow analysis Log mean temperature difference Effectiveness-NTU method	
22	Fri	12/1/23	Chapter 12: Radiation Basic Principles Blackbody Radiation	HW8

Tentative Course Schedule (Subject to Change)

23	Wed	12/6/23	Chapter 12: Radiation Real Surfaces	
24	Fri	12/8/23	Chapter 13: Radiation exchange View Factors Enclosures	HW9
25	Wed	12/13/23	Chapter 13: Radiation exchange The Re-Radiating Surface Multi-Mode Effects	**Project Final Report**

Final Exam: 12/20/23 Kupfrian Hall 202, 8:30AM – 11:00AM