Fall 2023

ME 407-101, HM1: Heat Transfer

EonSoo Lee

ME 407-101/HM1: Heat Transfer (2023 Fall)
Lecture: M 6.00 PM - 8.50 PM (CULM 111) (E.S. Lee)

Instructor: Dr. Eon Soo Lee (Office: MEC313) (Phone: 973-596-3318) (Email: eonsoo.lee@njit.edu)
Office hour: **M/W 2:00 - 3:00 PM** (MEC313, or WebEx) (https://njit.webex.com/meet/lee2000njit.edu).
Prior confirmation for meeting or appointments required.
Also available before or after the class or during the break in the classroom.

Objective: (i) To understand the basic heat transfer modes of conduction, convection and radiation, and
(ii) build up the capability to apply the heat transfer relations for the analysis of heating, cooling or thermal systems through HWs, Exams and Project.

Pre-requisite: Math 222 – Differential Equations, Linear Algebra/Matrix, or equivalent,
ME 311 – Thermodynamics I or equivalent (mass conservation, energy conservation, 1st law of Thermodynamics)
ME 304 – Fluid Mechanics (laminar/turbulent flow, boundary layer analysis, internal/external flow, Navier-Stokes equation)

Required Text books and related materials
Incropera and DeWitt, **Introduction to Heat Transfer, 6th edition**. John Wiley & Sons 2011, or equivalent.
Incropera and DeWitt, **Fundamentals of Heat and Mass Transfer, 7th edition**. John Wiley & Sons 2011, or equivalent.
(Older or newer version also fine for the lecture.)

Note: Substitute WebEx Room only for special emergent cases (Prior announcement to be emailed).
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ME 407-101/HM1 : Virtual Class Meeting Room Information

Monday, 6-8:50pm

https://njit.webex.com/njit/j.php?MTID=mbfd7b739a044ae3de63d0d3656e90d8f

Meeting number (access code): emailed.

Meeting password: emailed.

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- The WebEx virtual classroom is prepared only for substitute for special or emergency cases.
- If that's the case, the instructor will give a prior announcement through Canvas by email.
- Pay attention to Canvas announcement!

Weekly Lecture Schedule

Week		Contents	HW due	Remarks
1	(9/11)	Heat transfer course introduction, syllabus, project guideline. Short overview of PDE/Thermodynamics/Fluid mechanics Ch1: Intro to HTR (conduction, convection)		Add/Drop DL (9/11)
2	(9/18)	Ch1: Intro to HTR (radiation) (Thermodynamics) Ch2: Intro to conduction (Fourier's Law, Diffusion eqn, transient behavior		
3	(9/25)	Ch3: 1-D steady- plane wall, radial system w/o heat generation. Ch3: 1-D steady cond. – heat generation system.	HW1 (ch1&2)	
4	(10/2)	Ch3: 1-D steady cond. – fin analysis Ch4: 2-D steady cond.- SoV; shape factor		
5	(10/9)	Ch4: 2-D steady cond.- finite difference method **(Quiz #1)** Ch5: Transient Cond. – lumped capacitance method	HW2 (ch3)	
6	(10/16)	Ch5: Transient Cond. – one term approximation; semi-infinite solid Ch5: Transient Cond. – finite difference method (explicit, implicit)	HW3 (ch4)	
7	(10/23)	Ch6: Intro to Conv. – Boundary Layer, conv coefficient Ch6: Intro to Conv. –Non-dim parameters and Reynolds Analogy	HW4 (ch5)	Report Announce
8	(10/30)	**Midterm (Conduction. Ch1-5)** Short review and Lecture of Ch6		
9	(11/6)	Ch7: External flow – Flat plate in parallel flow Ch7: External flow – Cylinder in cross flow, Sphere	HW5 (ch6)	Planning report.
10	(11/13)	Ch8: Internal flow –fully develop, constant T & constant heat flux analysis Ch8: Internal flow- heat transfer correlations, entry length effect	HW6 (ch7)	Withdraw DL
11	(11/20)	Ch9: Free convection – laminar BL, Boussinesq approx., similarity Ch10. Pool boiling, film boiling, film condensation **(Quiz #2)**	HW7 (ch8)	Thanksgiving
12	(11/27)	Ch11. HEX- parallel and counter flow analysis, LMTD method Ch11. HEX- Effectiveness-NTU method		Progress report
13	(12/4)	Ch12. Radiation: Blackbody, Wien's Displacement law, S-B law, Kirchhoff's law Ch13. View factor	HW8 (ch9-11)	
14	(12/11)	Ch13. Radiation exchange: blackbody Ch13. Radiation exchange: opaque, gray body	Practice (ch12-13)	Final report
15	(12/18)	**Final Exam (Convection – Radiation)**		

* This schedule is subject to change during the actual running of the semester.

Grading Policies (Honor section will be separately graded from Regular section.)

(1) Grading (total 100): Grading Scale: A(>80), B (>70), C(>60), D (>50), otherwise curved.

- Homeworks (10): Eight (8) HWs total.
- Quizzes (20): Two (2) quizzes.
- Midterm (20)
- Final (30)
- Project (20): planning, progress, final reports.

Note-1: "NO EXAM" goes to ZERO point.

- except only for the **instructor-approved** & **officially documented** excuse from Dean of Students
  80% Rule: 80 % of the student's overall performance of all the other exams-Quiz,Midterm,Final

(2) **Homework: Individual submission (by Online submission to Canvas)**

- HWs are **due at 6 PM** on the due date in class.
  - Late submission **within one week** from the due date - **30% loss** in grading.
  - Late submission **over one week** from the due date – Not Accepted for grading (zero point).

Up to 30% loss if **not following** the guidelines below:

- HWs Must have a **cover page**. (see S1 for cover page guideline)
- Each problem MUST start on a **new page**. Don't put multiple problems on one page.
- Each problem should have the following headings:
  i. Known: A brief summary of the problem, "in your own words".
  ii. Find: Quantities to be determined.
  iii. Schematic: Sketch the physical system
  iv. Assumptions: Assumptions to be used in solving the problem are listed.
  v. Properties: Material properties needed, values and sources.
  vi. Analysis: Solve a problem in a systematic and logical manner, **showing all steps**.
  vii. **Final Answers MUST** be clearly given in a **BOX**.

(3) **Final project:** (see the guidelines for details in **S2. and S3. Final Project**)

- **2 members/team or Single member team**
- **Planning Report, Progress Report, Final Report** to be submitted on each deadline.
- Real life heat transfer problem: problem description, model development, analysis, BCs, ICs, etc
- Project progress meeting (if necessary) with Instructor available. See the details in **S4. Project Progress Meeting Guideline**.

(4) Exam Requirements (see the details in S5. Exam Guideline.)

- **Quizzes:** **Closed book/note. No formula sheet allowed.**
- **Midterm/Final:** **Closed book/note. No formula sheet allowed.**
- Simple Calculator (No programmable calculator). No share of calculator.
- No tele-communication tools, such as cell phone, lab-top, smart watch, etc.

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NJIT Canvas https://njit.instructure.com/courses (UCID login required)

- Check and update your contact email address in Canvas. Everything will be emailed through it.
- Every notice, changes and HWs, Exams information will be posted on Canvas, and sent through it.

**** **NJIT Honor Code – Strictly Enforced****
http://www5.njit.edu/policies/sites/policies/files/academic-integrity-code.pdf.