

Fall 2019

## ME 407-HM3: Heat Transfer

Eon Soo Lee

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**ME 407-101/HM3: Heat Transfer**  
**Lecture: M 6.00PM - 8.50PM (CKB 217)**

**(2019 Fall)**  
**(Dr. Lee)**

**Instructor:** Dr. Eon Soo Lee (Office: MEC 327)  
 Office hr: **M 6:00 PM -8:50 PM** or an appointment by ([consoo.lee@njit.edu](mailto:consoo.lee@njit.edu))

**Objective:** To understand the basic heat transfer modes and apply the heat transfer relations for the analysis of heating and cooling energy systems or thermal systems.

**Pre-requisite:** Math 222 – Differential Equations (PDE) or equivalent,  
 ME 304 – Fluid Mechanics,  
 ME 311 – Thermodynamics I

**Required Text books and related materials**

Incropera and DeWitt, An Introduction to Heat Transfer, 6th edition. John Wiley & Sons 2011, or equivalent.

Week	Contents	HW due	Remarks
1 (9/9)	Heat transfer course introduction, syllabus, project guideline Ch1: Intro to HTR (conduction, convection, radiation) (Thermodynamics) Ch2: Intro to conduction (Fourier's Law, Diffusion equation)		Drop DL (9/13)
2 (9/16)	Ch2: Intro to conduction (transient behavior) Ch3: 1-D steady state Cond.- plane wall, radial system		
3 (9/23)	Ch3: 1-D steady state cond. – heat generation system Ch3: 1-D steady state cond. – fin analysis	HW1 (ch1&2)	
4 (9/30)	Ch4: 2-D steady state cond.- SoV; shape factor Ch4: 2-D steady state cond.- finite difference method	HW2 (ch3)	(Quiz #1)
5 (10/7)	Ch5: Transient Cond. – lumped capacitance method Ch5: Transient Cond. – plane wall; radial, semi-infinite solid; constant T or q''	HW3 (ch4)	
6 (10/14)	Ch5: Transient Cond. – finite difference method Ch6: Intro to Conv. – Boundary Layer, conv coefficient		
7 (10/21)	Ch6: Intro to Conv. –Non-dim parameters Reynolds Analogy Ch7: Flat plate introduction	HW4 (ch5)	
8 (10/28)	Ch7: External flow – Flat plate in parallel flow <b>Midterm (Conduction Ch1-5)</b>	HW5 (ch6)	
9 (11/4)	Midterm quick review and Ch7: External flow – Cylinder in cross flow, Sphere Ch8: Internal flow –fully developed analysis: hydrodynamics & thermal		
10 (11/11)	Ch8: Internal flow –constant T & constant heat flux analysis Ch8: Internal flow- heat transfer correlations, entry length effect	HW6 (ch7)	Withdrawal DL (11/11)
11 (11/18)	Ch9: Free convection – laminar BL, Boussinesq approx., similarity, (Quiz #2) Ch10. Pool boiling, film boiling, film condensation Ch11. HEX- parallel and counter flow analysis	HW7 (ch8)	
12 (11/25)	Ch11. HEX- Effectiveness-NTU method Ch12. Radiation, Opaque & Blackbody, Wien's Displ. law, S-B law, Real surface, Kirchhoff's law		Thanksgiving
13 (12/2)	Ch13. View factor Ch13. Radiation exchange: blackbody,	HW8 (ch9-11)	
14 (12/9)	Ch13. Radiation exchange: opaque, gray Review	HW9 (ch12-13)	
	<b>Final Exam (Convection – Radiation)</b>		

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

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**Grading Policies**

- (1) Grading (total 110): Grading Scale: A (>90), B (>80), C (>70), D (>60) & F (< 60)
- Homeworks (20)
  - Quizzes (20)
  - Midterm (20)
  - Final (30)
  - Project (20)

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

(except only for the instructor-approved, **officially documented emergency** accident/medical excuse from the Dean of Students)

Note-2: There will be NO makeup test in this class.

Note-3: Only Instructor-approved, officially documented excuse from Dean of Students for no exam will get a partial consideration for the standing of the missed exam, based on the rest of the exam and overall performance standings.

- (2) Homework: **Individual submission** (see the next page **S1. HW Submission Guideline** for the cover page guideline.)
- HWs are due at the start of the class on the due date.
  - HW must be stapled!
  - No stapled or No sorted HWs will be Returned without grading (zero point).
  - No late submission accepted.
  - 20% discount if not follow guidelines.

**Each problem MUST start on a new page.** Don't put multiple problems on one page.

- Solve problems in a systematic and logical manner, **showing all steps.**
- **Final Answers MUST be clearly indicated with a box.**

- (3) Team Final project: guideline (see the details on the guideline in **S2. Final Project Guideline**)
- **3 members/team (Coordinator, Recorder, Checker)**
  - Real life heat transfer problem: problem description, model development, analysis, BCs, ICs, etc
  - Project progress meeting (Mandatory) with professor after Midterm. See the details for **S3. Project Progress Meeting Guideline** in the following pages.

- (4) Exam Requirements
- **One-page, both-sided, letter-size formula sheet (original hand-written only, no photo-copy, formula only)**
  - **Closed book; Closed notes/materials, except formula sheet.**
  - Simple Calculator (No programmable calculator). No share of calculator.
  - No tele-communication tools, such as cell phone, lab-top, smart watch, etc.

- (5) - Be on-time in class for HW submission, class instructions and information at the start of the class.  
- No late attendance more than 10 minutes be allowed to get in the class in order to avoid the distraction of the class

\*\*\*\* S4. **NJIT Honor Code – Strictly Enforced**\*\*\*\*

<http://www5.njit.edu/policies/sites/policies/files/academic-integrity-code.pdf>.

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NJIT Canvas <https://njit.instructure.com/courses> (UCID login required)  
(Moodle at NJIT <http://njit2.mrooms.net/> (UCID login required) or <http://moodle.njit.edu/> )

Be familiar with NJIT Canvas!!!

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

## **S1: HW Submission Guideline**

- Each HW will be posted on Canvas with due date, and emailed by the Canvas system to your njit email address registered in Canvas system.
- It's your responsibility to update your email address on the Canvas system.
- HW is accepted only as an individual HW.
- HW MUST be submitted with cover page as followed by the example format.
- **cover page**: write HW# and the corresponding chapter, submission date, names, etc as shown below.

**Each problem MUST start on a new page. Don't put multiple problems on one page.**

- Known: A brief summary of the problem, "in your own words".
- Find: Quantities to be determined.
- Schematic: Sketch the physical system
- Assumptions: Assumptions to be used in solving the problem are listed.
- Properties: Material properties needed, values and sources.
- Analysis: Solve a problem in a systematic and logical manner, **showing all steps.**

**Final Answers MUST be clearly indicated with a box.**

===== **HW cover page example** =====

## **ME 407-101: Heat Transfer.**

### **HW Set #1 (Chapter 1 & 2)**

**Sam Lincoln, 312-12-123**

**DUE date: September 16, 2019 (at the start of the class)**

**Submission date: 9/16/2019 (at the start of the class)**  
**(or a different date or time if submitted on the different date or time)**

**Problem solved: total 4 problems answered out of 5**

1-3,  
1-15,  
2-5,  
2-17

**Problem not solved: 2**

2-23

## S2. Final Project Guideline

### A. Team Size and Role

- \* Standard size of team is **3 students**. (Different size of team is NOT acceptable WITHOUT APPROVAL.)
- \* Formulate your team by yourself with your choices and preferences
- \* Team role recommended: One Coordinator, One Recorder, One Checker
  - **Coordinator**: team meeting coordination, meeting date/time/place coordination, meeting agenda coordination. Keep moving the project. etc. Keep everyone on task and get involved.
  - **Recorder**: meeting recording/minutes, sharing the meeting outcomes, etc. Final project submission.
  - **Checker**: project progress check and update, sharing the status of the project, etc. Final report guideline check. Final project submission double check.
- \* Team member evaluation form will be submitted individually after the project submission. (by individual emails)
- \* A team can set a different team role with its choice for better performance.

### B. Scope of Project Problem

1. You need to create your own problems from our real life systems. For example, engine, engine cooling radiator, boiler, computer chip cooling, swimming suit, satellite, jet engine, etc
2. More creative problem is preferred.
3. Conduction, convection and radiation- mixed problem is preferred. or the problem with at least two of heat transfer mode mixed is preferred.

### C. Standard Report Guideline (Final project page limit: 15 pages)

#### General section:

1. cover page: course name, project team members and roles, project title, submission date, etc
2. abstract (~ 0.5 pg)
3. role description of each team member in the project activities and developments ( ~ 0.5 pg).
4. table of contents (~ 1 pg)

#### Technical Narrative sections:

5. motivation, objectives, etc (~ 1 pg)
6. introduction and background of the problem, ( ~ 2-3 pg)
7. model development, model geometry, assumptions, etc: detail descriptions ( 2- 3 pg)
8. theory: detailed explanations of the thermal or heat transfer theory applied to the problems. (2-3 pg)
9. Analysis: analytical or computational analysis, explanations of computational approaches, etc (2-4 pg)
10. Results and discussion: Not only showing figures, graphs, but also explaining them, etc (2-3 pg) and more of your choices for better project report.
  - All the page numbers are only for recommended suggestions, not for a limit.

#### References and Appendix: (No limit. Below are not included in the page limit of 15.)

A. references

B. Appendix if any (Any materials that are not included in the body section due to the page limit can be attached.)

### D. Writing Format Guideline (see the Note-2 in the evaluation section for importance)

- \* **Page limit: maximum 15 pages** including all the figures and tables in technical narrative sections from motivation to the end of results and discussion. References and Appendix are not counted in this 15-page limit.
- \* Format:
  - **Letter size,**
  - **1-inch margin,**
  - **Font size 11 for body text, (Bigger font for heading is OK.)**
  - **Times New Roman or Arial font,**
  - **Single-spaced line.**
  - (Bigger font size for title/outline/heading is acceptable.).

- Bold or italic font are also acceptable for outlines or highlights.

\* Plagiarism check (from other project reports, web sources, book sources, etc) will be performed: Honor Code strictly reinforced.

## **E. Evaluation**

- Final project evaluation guideline:

### General section: (10%)

1. cover page: course name, project team members and roles, project title, submission date, etc
2. abstract
3. role description of each team member in the project activities and developments
4. table of contents

### Technical Narrative sections: ( 80%)

5. motivation, objectives, etc (~ 10%)
6. introduction or background of the problem, (~ 10%)
7. model development, model geometry, assumptions, etc: detail descriptions (~ 10%)
8. theory: detailed explanations of the thermal or heat transfer theory applied to the problems. (~ 20%)
9. Analysis: analytical or computational analysis, explanations of computational approaches, etc (~20%)
10. Results and discussion: Not only showing figures, graphs, but also explaining them, etc (~10%)
  - \* Note-1: the percentage of each individual section is not a strict limit but more dependent on the development of the contents of final project outcomes.

### References and Appendix: (10%)

- A. references
- B. Appendix if any (Any materials that are not included in the body section due to the page limit can be attached.)

Example evaluation:

90%: strong background study, model develop, model analysis, in-depth analysis, conv/cond/rad mix-up problem,  
80%: fairly good, may be a typical problem, may have some weak analysis, or results is generally good,  
70%: weak at some sections, typical problem, weak analysis,  
60%: very weak, overall, poor analysis/result/discussion, overall contents NOT complete,

\*Note-2: 20% discount if not follow the guideline on writing format and page limit, or late submission.

## **F. Submission Format and Due Date**

\* **MS word & pdf** format, **both** format of file should be **submitted**.

\* Final project due date: **DEC 12, THURSDAY 6:00 pm** by email to **<eonsoo.lee@njit.edu>**.  
(Submission window: DEC 9-12, 2019)

- **Submission Email title** format: "**2019F-ME407-101(HM3) HTR Final Project (Name1\_Name2\_Name3)**".

- **File name** (similar to Email title): "**2019F-ME407-101(HM3) HTR Final Project (Name1\_Name2\_Name3)**"

\*Note: Other format of title or file name of submission may be delayed on grading for final, and **20% discount**.

### **S3. Project Progress Meeting (Mandatory) Guideline** **: to be announced by Canvas**

Team member: Coordinator, Recorder, Checker, at least.

1. Objective: Project members will have a mandatory project meeting with the instructor of the class, to get a guidance and advices on the project and to have a discussion for a possible way of solution or progress to the completion of the project problem
2. Meeting time and arrangement
  - i. Meeting date: within the time frame of 3<sup>rd</sup> or 4<sup>th</sup> week of November (11/18-11/27)
  - ii. Duration of the meeting: ~ less than 20 min/team
  - iii. Available meeting slots will be posted on Moodle. Each team will internally communicate and decide the meeting slot, and the Team Coordinator should send the email to the instructor.
  - iv. Official communication channel with instructor regarding the meeting time arrangement of the final project is limited to Team Coordinator, to avoid confusion and to manage conflicts in time arrangement. However, the Coordinator should include all the team member in the email communications with the instructor.
  - v. Team Coordinator is responsible to communicate with all the team member before communicating with the instructor.
  - vi. Project progress materials should be emailed by the Coordinator to the instructor 24 hrs before the meeting time, for the prior review and understanding.
  - vii. Meeting slots will be filled by first-come-first-serve basis through the email from the Coordinator.
  - viii. Key email information should be included in every email communication:
    - Coordinator name,
    - team member name and each role,
    - project title or name, and one sentence representing the project, if available.

## **S4. NJIT Honor Code**

**NJIT Honor Code is strictly enforced over the course of all the activities including HWs, EXAMs and Projects.**

**\*\*\*\* NJIT Honor Code – Strictly Enforced\*\*\*\***

<http://www5.njit.edu/policies/sites/policies/files/academic-integrity-code.pdf>.

*“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](mailto:dos@njit.edu)”*