Fall 2025: ME407 Heat Transfer

Instructor: Dr. Yufeng Song
Email: Yufeng.Song@njit.edu

Class: Days/Times –Monday (6:00 PM – 8:50 PM);
FMH 306, Credits – 3.00

Office Hours: There are no specific office hours. Please email me to schedule an appointment. We can meet on any day at our mutually convenient time.

Prerequisites:
- Math 222 – Differential Equations, Linear Algebra/Matrix, or equivalent,
- ME 311 – Thermodynamics I or equivalent (energy conservation, 1st law of Thermodynamics)
- ME 304 – Fluid Mechanics (laminar/turbulent, boundary layer analysis, internal/external flow, nondimensional analysis and parameters)

Textbook: **Fundamentals of Heat and Mass Transfer**, 8th edition, by Theodore L. Bergman, Adrienne S. Lavine, Frank P. Incropera, David P. DeWitt,Wiley, ISBN: 978-1-119-35388-1

Course Description: This course introduces the three fundamental modes of heat transfer—conduction, convection, and radiation—and their role in engineering systems. Emphasis is placed on the physical interpretation of governing principles, the use of numerical methods, and the application of theory to the analysis and design of practical systems such as heat exchangers.
By the end of the course, students will:
- Understand the fundamental laws and mechanisms of heat transfer and their implications for system behavior.
- Develop and apply models to analyze and design heat transfer systems.
- Strengthen problem-solving skills essential for addressing real-world engineering challenges in thermal sciences.

Outcome of the course:
(i). **mathematically** describe different practical heat transfer problems including governing equations together with boundary and initial conditions
(ii). **solve** the heat transfer problems for a range of practically important simplified configurations and symmetries, including one-dimensional problems in cylindrical and spherical coordinates
(iii). **use** generic data processing software to solve heat transfer problems
(iv) **apply** finite difference methods for transient heat transfer in a solid with or without distributed heat sources
(v). **describe** engineering heat transfer problems using non-dimensional criteria, such as Reynolds number, Nusselt number, Rayleigh number, etc
(vi). **determine** engineering design quantities (power, requirements, insulation thickness, thermal conductivity, exchanger size, etc.) required for design of thermal engineering devices and systems

Course Syllabus

Classes		Topic	Chapter
1	09/08	Heat transfer course introduction, syllabus Ch1: Intro to HTR (conduction, convection) Ch1: Intro to HTR (radiation) (Thermodynamics)	**1**
2	09/15	Ch2: Intro to conduction (Fourier's Law, Diffusion eqn, transient behavior Ch3: 1-D steady- plane wall	**2&3**
3	09/22	Ch3: 1-D steady- radial system w/o heat generation. Ch3: 1-D steady cond. – heat generation system.	**3**
4	09/29	Ch3: 1-D steady cond. – fin analysis Ch4: 2-D steady cond.- SoV; shape factor	**3 &4**
5	10/06	Ch4: 2-D steady cond.- finite difference method Ch5: Transient Cond. – lumped capacitance method	**4&5**
6	10/13	Ch5: Transient Cond. – one term approximation; semi-infinite solid Ch5: Transient Cond. – finite difference method (explicit, implicit)	**5**
7	**10/20**	**Midterm Exam**	
8	10/27	Ch6: Intro to Conv. – Boundary Layer, conv coefficient Ch6: Intro to Conv. –Non-dim parameters and Reynolds Analogy	**6**
9	11/03	Ch7: External flow – Flat plate in parallel flow Ch7: External flow – Cylinder in cross flow, Sphere	**7**
10	11/10	Ch8: Internal flow –fully develop, constant T & constant heat flux analysis Ch8: Internal flow- heat transfer correlations, entry length effect	**8**
11	11/17	Ch9: Free convection – laminar BL, Boussinesq approx., similarity Ch10. Pool boiling, film boiling, film condensation	**9&10**
12	11/24	Ch11. HEX- parallel and counter flow analysis, LMTD method Ch11. HEX- Effectiveness-NTU method	**11**
13	12/01	Ch12. Radiation: Blackbody, Wien's Displacement law, S-B law, Kirchhoff's law Ch13. View factor	**12-13**
14	12/08	Ch13. Radiation exchange: blackbody Ch13. Radiation exchange: opaque, gray body	**13**
15	**12/15**	**FINAL EXAM**	

EVALUATION SCHEME:

Your course grade will be determined as follows:

• Homework	25 %
• Attendance and Class Participation	5 %
• 2 Quizzes	10 %
• Midterm Exam	25 %
• Final Exam	35 %

TENTATIVE GRADING SCHEME:

Letter Grade	Total Weighted Mark
A	> 90
B+	85-89.9
B	80-84.9
C+	75-79.9
C	70-74.9
D	60-69.9
F	< 60