# MECH 4315: Heat Transfer

Class time and location: MTWR 1200 - 1305, Liberal Arts Building 102
Instructor: Dr. Piyush Kumar, pkumar2@utep.edu
Teaching Assistant: Md Fazlay Alam, malam8@miners.utep.edu
Office hours: Friday 1200 – 1305 (E330) or by appointment (MS Team)

Textbook: "*Y.A. Çengel and A.G. Ghajar, Heat and Mass Transfer: Fundamentals & Applications, 6th Edition, McGraw-Hill, ISBN 1260440001*". Instructors may provide additional reading materials.

Blackboard: The instructor will use Blackboard for uploading lecture slides, updating the syllabus (if necessary), and communicating with students via "Announcements" and email.

Prerequisites: MECH 3312 Thermodynamics and MECH 3314 Fluid Mechanics

Class delivery: The class will be delivered in in-person mode or as informed by the instructor.
Participation requirements: You must attend at least 75% of all the classes in person.

Goals and Objectives:
The course aims to familiarize students with the fundamental principles of heat and mass transfer and explore their distinct applications.

- Identify and Solve Heat Transfer Problems: Master the three modes of heat transfer—conduction, convection, and radiation—and solve basic multi-mode heat transfer problems.
- Formulate and Solve Heat Conduction Equations: Develop and solve the differential equations for heat conduction in various coordinate systems, applying appropriate thermal boundary conditions.
- Develop Thermal Resistance Networks: Create thermal resistance networks to address practical heat conduction challenges.
- Solve Transient Heat Conduction Problems: Address transient lumped-parameter heat conduction problems effectively.
- Analyze Convective Heat Transfer: Evaluate convective heat transfer in boundary layers and internal pipe flows using Newton's law of cooling.
- Analyze Radiative Heat Transfer: Analyze radiative heat transfer between non-black surfaces.

Knowledge, Skills, and Abilities gained: Students completing the course will acquire a robust understanding of heat and mass transfer principles, encompassing conduction, convection, and radiation. They will develop the ability to formulate and solve differential equations for heat conduction in various coordinate systems, create thermal resistance networks for practical conduction problems, and address transient lumped-parameter heat conduction scenarios. Additionally, students will gain skills in analyzing convective heat transfer in boundary layers and internal pipe flows, and in evaluating radiative heat transfer between non-black surfaces. These competencies will equip them to tackle complex multi-mode heat transfer problems effectively.

**ABET Program Outcomes**

- An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics

**MATERIALS COVERED**:

- **Basic Concepts of Thermodynamics and Heat Transfer**
- **Heat Conduction**
- **Convection**
- **Heat Exchanger**
- **Radiation Heat Transfer**
- **Boiling and Condensation**

**GRADING**: There will be several assignments at regular intervals during the semester. You are required to submit the assigned work on or before the deadline. Late submission of the assigned work will not be allowed unless medical and emergency reasons exist. The following percentages of the assignments, exams, and projects will constitute the basis for the assigning of the final grade in the course:

Class performance & Quizzes: 15%, Homework: 15%, attendance: 10%
Exam 1: 20%, Exam 2: 20%, Exam 3: 20%
Grading criterion:

A ($\geq 90\%$)
B ($<90\% \ \& \geq 80\%$)
C ($<80\% \ \& \geq 70$)
D ($<70\% \ \& \geq 60\%$)
F ($<60\%$)

Note: Any outstanding issues related to grading of assigned work (quizzes, exams, homework or projects) must be resolved within two weeks from the day the graded work is returned. There will be no makeup exams or quizzes.

**Academic Misconduct:** Students are encouraged to work together to discuss the subject, however, all graded materials must represent the student's individual work. Scholastic dishonesty is the attempt of any student to present as his or her own work of another, or any work which he/she has not honestly performed, or attempting to pass any examination by improper means. Scholastic dishonesty is a serious offense and will not be accepted. Academic misconduct will be handled according to the current university policy.

Reasonable Accommodation Policy: Any student in this course who has a disability that may prevent him or her from demonstrating his or her abilities should contact me personally as soon as possible so we can discuss the accommodation necessary to ensure full participation and facilitate your educational opportunities.

# COURSE PLAN

**Basic Concepts of Thermodynamics and Heat Transfer**
Week 1:
- Thermodynamics and Heat Transfer
- The First Law of Thermodynamics
- Heat Transfer Mechanisms
  - Conduction
  - Convection
  - Radiation

**Heat Conduction**
Week 2:
- Introduction
- One-Dimensional Heat Conduction Equation
- General Heat Conduction Equation
- Heat Generation in a Solid

**Steady Heat Conduction**
Week 3:
- Steady Heat Conduction in Plane walls
- Generalized Thermal Resistance Networks
- Heat Conduction in Cylinders and Spheres
- Critical Radius of Insulation
- Heat Transfer from Finned Surfaces

**Transient Heat Conduction**
Week 4:
- Lumped System Analysis
- Transient Heat Conduction in Large Plane Walls, Long Cylinders and Spheres

**Convection Heat Transfer**
Week 5 and 6:
- Fundamentals of Convection
- External Forced Convection
- Internal Forced Convection
- Natural Convection

**Heat Exchangers**

Week 7:

- Type of Heat Exchanger
- The Overall Heat Transfer Coefficient
- The Log Mean Temperature Difference Method
- The Effectiveness-NTU Method

**Radiation Heat Transfer**

Week 8:

- Fundamentals of Thermal Radiation
- Radiation Heat Transfer

**Boiling and Condensation**

Self-Study:

- Boiling Heat Transfer
  - Pool Boiling
  - Flow Boiling
- Condensation Heat Transfer
  - Film Condensation
  - Dropwise Condensation