MECH 2311 - Introduction to Thermal-fluid Science

Class time and location: MTWR 1315 - 1420, Liberal Arts Building 108
Instructor: Dr. Piyush Kumar, pkumar2@utep.edu
Teaching Assistant: Md Fazlay Alam, malam8@miners.utep.edu
Office hours: Friday 1315 – 1420 (E330) or by appointment (MS Team)

Textbook: "*Yunus Cengel, John Cimbala, and Robert Turner, Fundamentals of Thermal-Fluid Sciences Sixth Edition (2021) by McGraw Hill*". 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: Basic concept of Mathematics

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 goal of the course is to introduce students to the foundational principles and applications of thermal fluid sciences, encompassing the key concepts of fluid mechanics, thermodynamics, and heat transfer.

- Studies the interaction of work, heat, and energy changes during state transitions, governed by the laws of thermodynamics.
- Examines the changes in mass, energy, and momentum in fluid movement, focusing on the mass flow in open systems as part of the energy balance.
- Analyzes heat transfer by conduction, convection, and radiation to evaluate the rate of heat transport between different temperatures.

Knowledge, Skills, and Abilities gained:

- Comprehensive Understanding: Gain a deep understanding of the principles governing classical thermodynamics, fluid mechanics, and heat transfer, including energy interactions, fluid flow, and modes of heat transfer.
- Analytical Proficiency: Develop the ability to formulate, analyze, and solve problems involving conservation of mass, energy, and momentum, as well as transient and steady-state heat transfer scenarios.
- Practical Application: Acquire skills to apply theoretical knowledge to real-world systems, such as energy evaluation, fluid transport, and thermal management, using thermodynamic properties, fluid dynamics, and heat transfer techniques.

ABET Program Outcomes

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

MATERIALS COVERED:

- **Introduction and basic principles including mechanics and fluid statics**
- **Thermodynamic concepts and principles**
- **Thermodynamic and transport properties**
- **First and second laws of thermodynamics, energy and entropy analysis**
- **Control volume analysis**
- **Fluid statics**
- **Introductory fluid dynamics**
- **Continuum analysis**
- **Internal and external flows and convection principles**
- **Conduction, thermal resistance, and transient analysis**
- **Forced convection and the basics of thermal radiation**

GRADING: There will be several assignments/homework 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 ($<80\%$ & ≥ 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

The Thermal/Fluid Sciences: Introductory Concepts

Week 1:

- Introduction
- Thermodynamics
- Fluid Mechanics
- Heat Transfer
  - Conduction
  - Convection
  - Radiation

Thermodynamics: Preliminary Concepts and Definitions

Week 1:

- Systems and Control Volumes
- Properties of a System
- Density and Specific Gravity
- State and Equilibrium
- Temperature and the Zeroth Law of Thermodynamics
- Pressure

Energy and the First Law of Thermodynamics

Week 2:

- Forms of Energy
- Work
- Heat
- First Law of Thermodynamics
- Ideal Gas

Properties of Pure Substances

Week 3:

- P-v-T Relationships
- Real Gas Behavior
- Polytropic Process for an Ideal Gas
- Control Volume Mass and Energy Analysis

The Second Law of Thermodynamics

Week 4:

- Introduction
- The Kelvin-Planck Statement and Heat Engines
- The Clausius Statement: Refrigerators and Heat Pumps
- Reversible and Irreversible Process
- The Carnot Cycle
- Entropy

Introduction to Fluid Mechanics

Week 5 and 6:

- Introduction
- Fluid Properties and Flow Properties
- Laminar and Turbulent Flow
- Pressure and Fluid Statics
- Bernoulli and Energy Equations

Heat Transfer

Week 7 and 8:

- Heat Transfer Mechanisms
  - Conduction
  - Convection
  - Radiation