MECH 3314: Fluid Mechanics

Class time and location: MTWR 0930 - 1035, Chemistry Computer Sci Bldg 1.0202
Instructor: Dr. Piyush Kumar, pkumar2@utep.edu
Teaching Assistant:
Office hours: Friday 0930 – 1035 (E330) or by appointment (MS Team)

Textbook: "*Cengel, Y. A. and Cimbala, J. M., Fluid Mechanics Fundamental and Applications, 2006, Second Edition, McGraw-Hill Inc. NY, ISBN 0-07-247236-7*". Instructors may provide additional reading materials.
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: Fluid Mechanics is a fundamental course in mechanical engineering. The purpose of this course is to give you an understanding of the physical mechanisms involved in fluid flows including predictions of flows and resulting forces. This course covers fundamental concepts of fluid mechanics with a broad range of engineering and technological applications. An understanding of fluid mechanics is necessary since fluid dynamical processes are an essential part of the design processes of vehicles, power plants, chemical processing units, buildings, bridges, and among others.

Knowledge, Skills, and Abilities gained: Knowledge of physical quantities important to fluid flow, Ability to apply fundamental laws in control volume form to engineering situations, Knowledge of fluid flows in pipes and around objects, and Ability to apply basic laws of fluid mechanics to compute various quantities.

Impact on subsequent courses in curriculum: Knowledge needed to understand heat transfer, thermal design, and other thermal fluid system courses.
Prerequisites: All students taking the course must have a basic knowledge of engineering (Thermodynamics laws, Newtonian Mechanics/Laws) and differential and integral calculus.

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 Concepts**
- **Pressure and Fluid Statics**
- **Fluid Kinematics**
- **Bernoulli and Energy Equations**
- **Momentum Analysis of Flow Systems**
- **Dimensional Analysis**
- **Internal Flow**
- **External Flow: Drag and Lift**
- **Turbomachinery**

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 (≥ 90%)
B (<90% & ≥ 80%)
C (<80% & ≥ 70)
D (<70% & ≥ 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

Introduction and Basic Concepts
Week 1:
- Introduction
- The non-slip Conditions
- Classification of fluid flows
- System and Control Volume
- Properties of fluids

Pressure and Fluid Statics
Week 2:
- Pressure and Pressure measurement device
- Introduction to Fluid Statics
- Hydrostatic Forces on Submerged Plane Surfaces
- Hydrostatic Forces on Submerged Curved Surfaces
- Buoyancy and Stability

Fluid Kinematics
Week 3:
- Lagrangian and Eulerian Descriptions
- Flow patterns and Flow Visualization
- Vorticity and Rotationality
- The Reynolds Transport Theorem

Bernoulli and Energy Equations
Week 4:
- Introduction
- Conservation of Mass
- The Bernoulli Equation
- Derivation of the Bernoulli Equation
- Limitations on the Use of the Bernoulli Equation
- Applications of the Bernoulli Equation
- General Energy Equation
- Energy Transfer by Heat
- Energy Transfer by Work

Momentum Analysis of Flow Systems
Week 5:
- Newton’s Laws
- Choosing a Control Volume
- Forces Acting on a Control Volume
- The Linear Momentum Equation
- The Angular Momentum Equation

Dimensional Analysis
Week 6:
- Dimensions and Units
- Dimensional Homogeneity
- Dimensional Analysis and Similarity
- The Method of Repeating Variables and the Buckingham Pi Theorem

Internal Flow
Week 7:
- Introduction
- Laminar and Turbulent Flows
- The Entrance Region
- Laminar Flow in Pipes
- Turbulent Flow in Pipes
- Minor Losses
- Piping Networks and Pump Selection

External Flow: Drag and Lift
Week 8:
- Introduction
- Drag and Lift
- Parallel Flow over Flat Plates
- Flow over Cylinders and Sphere

Turbomachinery
<u>Self-Study:</u>
- Classifications and Terminology
- Pumps
  - Pump Performance Curves and Matching a Pump to a Piping System
  - Pump Cavitation and Net Positive Suction Head
  - Pumps in Series and Parallel
  - Positive-Displacement Pumps
  - Centrifugal Pumps
- Turbines
  - Positive-Displacement Turbines
  - Impulse Turbines
  - Reaction Turbines