Course Outline for ENGR 466: Gas Dynamics and Boundary Layer Flow (3 units)

Instructor: Professor Ahmad R. Ganji, P.E.

Course Designation: Elective for Mechanical Engineering

Bulletin Description:
Prerequisites: ENGR 303 (Thermodynamics) and ENGR 304 (Fluid Mechanics)
Review of the fundamentals of fluid dynamics, formulation and application of compressible fluid flow, shock waves, concept and formulation of laminar and turbulent boundary layers, external flows, flow around immersed bodies.

Text:

Additional references:

Prerequisite by Topic:
1. Principle of conservation of mass
2. Principle of conservation of energy
2. Application of Second Law of Thermodynamics to flow processes
3. Application of Newton’s Second Law of Motion to fluid systems
4. Perfect gas law and properties of perfect gases

Course Objectives:
1. Introduce students to the fundamentals and applications of compressible fluid flow; (A, E)
2. Introduce students to basics of boundary layer and its applications; (A, E)
3. Introduce students to flow over immersed bodies; (A, E)
4. Introduce students to the fundamentals of turbomachines and their performance; (A’E)

Topics
1. Review of Basic Principles of Fluid Mechanics (1 weeks)
2. Introduction to Compressible Fluid Flow (2 weeks)
3. Steady One Dimensional Compressible Fluid Flow and Its Applications (3 weeks)
   - Isentropic Flow in Ducts of Variable Area
   - Nozzles and Diffusers
   - Normal Shock Waves
   - Adiabatic Flow in Constant Area Duct
   - Wind Tunnels
4. Viscous Flow over Surfaces (3 weeks)
   - The Concept of Boundary Layer

\[^1\] Indexes in parentheses refer ABET student outcomes
- Boundary Layer over Flat Plates
5. Flow over Immersed Bodies, Lift and Drag (1 week)
6. Introduction to Turbomachinery (4 weeks)
   - Classification of Turbomachines
   - The Centrifugal Pump
   - Performance Cures and Similarity Rules in Turbomachines
   - Matching Pumps to Systems Characteristics

Course Administration:
The course will be conducted through two 75 minute lectures per week. Homework will be assigned on a regular weekly basis. Two design projects will be assigned.

Evaluation:
1. Homework 10% (Assigned on a weekly basis)
2. Projects 20%
3. Midterms 35% (7th and 12th week)
4. Final 35%

Performance Criteria:
Objective 1. The student will demonstrate basic understanding and knowledge of compressible fluid flow and apply it to simple compressible fluid flow systems; (1,2,3,4)

Objective 2. The student will demonstrate basic understanding and knowledge of boundary layer flow and apply it to simple frictional flow systems; (1,2,3,4)

Objective 3. The student will demonstrate basic understanding and knowledge of flow over immersed bodies and be able to calculate lift and drag over simple systems; (1,2,3,4)

Objective 4. The student will demonstrate basic understanding and knowledge of turbomachinery systems and able to select proper size pumps to match with system’s performance; (1,2,3,4)

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2 Numbers in parentheses indicate evaluation methods used