Fluid Mechanics

1. **Course number and name:** 020MEFES1 Fluid Mechanics

2. **Credits and contact hours:** 6 ECTS credits, 3x1:15 contact hours per week

3. **Name(s) of instructor(s) or course coordinator(s):** Cynthia Andraos

4. **Instructional Materials:** PowerPoint slides; course handouts; lab experiments
   References:
   Class Notes by Sélim CATAFAGO.
   Textbook: White, F. M. (2017). Fluid Mechanics (8th ed.). McGraw-Hill.

5. **Specific course information**
   a. **Catalog description:**
   This course provides an in-depth understanding of fluid mechanics principles and their applications in mechanical engineering. Students will explore the fundamental concepts of fluid behavior, fluid statics, fluid dynamics, and the practical aspects of fluid flow in mechanical processes. The course emphasizes the analysis and design of fluid systems, including the fundamental elements for understanding incompressible and compressible fluid flow using mass, momentum, energy conservation principles and resolution of the characteristic fluid flow equations through the application of analytical and analogous methods.

   b. **Prerequisite:** Mechanics 2 (020MC2CI3 or 020MC2NI3).

   c. **Required** for ME students.

6. **Educational objectives for the course**
   a. **Specific outcomes of instruction:**
   By the end of the course, students should be able to:
   - Apply fundamental principles of fluid mechanics to solve engineering problems in mechanical processes
   - Analyze fluid behavior, including fluid statics and dynamics
   - Apply hydrostatic laws to calculate forces on surfaces
   - Understand and apply the equations of motion and continuity to solve problems related to fluid flow
   - Use Bernoulli's equation to calculate pressures and velocities
   - Study an ideal fluid flow using potential flow theory
   - know about dimensionless analysis and similitude
   - Interpret and analyze experimental data related to fluid mechanics
   - Demonstrate effective communication skills in presenting and discussing fluid mechanics concepts and have scientific writing skills

b. PI addressed by the course:

PI	1.1	1.2	1.3	6.1	6.2	6.3	6.4
Covered	x	x	x	x	x	x	x
Assessed	x	x	x	x	x	x	x

7. Brief list of topics to be covered

Introduction
- Categories of fluid mechanics
- Application in mechanical engineering
- Brief history

Chapter 1: Fundamentals
- Useful concepts
- Properties of fluids

Chapter 2: Fluid Statics
- Pressure
- Hydrostatic forces
- Buoyancy and stability
- Fluids in a rigid-body motion

Chapter 3: Fluid Kinematics
- Lagrangian and Eulerian descriptions
- Particle derivative and acceleration
- Streamlines, streaklines and pathlines
- Translation, rotation, and deformation
- Reynolds transport theorem

Chapter 4: Balance Equations
- Conservation of Mass
- Conservation of linear Momentum
- Conservation of angular Momentum
- Conservation of Energy
- Bernoulli's equation

Chapter 5: Ideal Fluids Dynamics - Local Formulation
- Introduction
- Differential equation of mass conservation
- Differential equation of momentum
- Differential equation of angular momentum
- Differential equation of energy
- Boundary conditions

Chapter 6: Flows of Ideal Fluids
- Stream function - Incompressible flow
- Velocity potential - Irrotational flow
- Cauchy-Riemann conditions
- Potential Flow Theory and examples of planar flows

Chapter 7: Dimensional Analysis – Similarity
- Dimensions and units

- Dimensional homogeneity
- Buckingham's π theorem
- Similarity

Chapter 8: External flow: Drag and Lift

- Friction and Pressure Drag
- Drag coefficients of common geometries
- Parallel flow over flat plates
- Flow over cylinders and spheres
- Lift

Chapter 9: Compressible Flow

- Stagnation Properties
- One-Dimensional Isentropic flow
- Isentropic flow through nozzles
- Shock waves and expansion waves

Laboratory experiments:

- Forces on plates
- Venturi meter and Bernouilli’s equation
- Flow through an orifice
- Viscosity measurements.