# FLUID MECHANICS AND MACHINES

**ENME 255**

**Lecture : 3** **Year : II**
**Tutorial : 1** **Part : II**
**Practical : 3/2**

**Course Objectives:**
The objective of this course is to provide students with basic concepts of fluid mechanics and machines with different practical applications. After completing the course, they can apply this knowledge to their daily lives and solve basic engineering problems related to fluids and fluid machinery.

**1 Introduction (2 hours)**

1.1 Definition, basic concepts, and area of application
1.2 Units and dimensions
1.3 Properties of fluid: Density, specific weight, specific volume, specific gravity
1.4 Viscosity, surface tension, capillarity, compressibility, bulk modulus, vapor pressure

**2 Fluid Statics (7 hours)**

2.1 Pascal's law of hydrostatic (Pressure intensity at a point)
2.2 Equation of fluid statics
2.3 Pressure: Definition and types
2.4 Pressure measurement devices: Manometers, mechanical gauges
2.5 Forces and center of pressure on submerged surfaces: Horizontal, vertical, inclined,
2.6 Principle of floatation: Meta center, metacentric height, and its determination
2.7 Conditions of equilibrium for submerged and floating body

**3 Fluid Dynamics (10 hours)**

3.1 Method of fluid flow analysis: Lagrangian and Eulerian
3.2 Types of fluid flow: One/Two/Three dimensional flows, steady/unsteady flow, uniform/non-uniform flow, laminar/turbulent flow, compressible/ incompressible flow, rotational/irrotational flow
3.3 Basic laws of fluid dynamics: Conservation of mass, conservation of linear momentum, conservation of energy
3.4 Continuity equations and applications: One-dimensional steady flow, rectangular coordinate system
3.5 Euler's equation of motion

3.6 Bernoulli's equation and applications: Pipe flow, flow from a tank, and siphon flow
3.7 Momentum equation and applications: Elbow reactions, fixed and moving blades
3.8 Navier-Stokes equation

**4 Viscous Flow (4 hours)**

4.1 Reynold's experiment
4.2 Boundary layer: The concept of development and zones on it
4.3 Separation of boundary layer and methods of controlling
4.4 Viscous flow in horizontal: Between parallel plates and circular tubes
4.5 Drag force on the flat plate due to boundary layer

**5 Pipe Flows (4 hours)**

5.1 Frictional resistance to flow in pipes: Darcey-Weisbach equation, friction factor, use of Moody diagram, head loss
5.2 Local head losses: Inlet, bends, expansion and contraction joints, valve
5.3 Hydraulic and energy grade lines: Reservoirs and pipe flow, pumps, and turbines

**6 Flow Measurement (4 hours)**

6.1 Measurement of static pressure intensity
6.2 Measurement of velocity; Pitot tube, Pitot-static tube, particle image velocimetry (PIV)
6.3 Restriction flow meters: Orifice plate, flow nozzles, Venturi, laminar flow elements
6.4 Linear flow meters: Rotameter, turbine flow meter, vortex flowmeter, elbow meter, electromagnetic and ultrasonic flow meters
6.5 Weir and notches: Classification and flow measurement

**7 Dimensional Analysis and Similitude (5 hours)**

7.1 Dimensional analysis: Use, advantages and limitations
7.2 Model analysis: Use, advantages and limitations
7.3 Forces in fluids and dimensionless numbers
7.4 Similitude: Geometric, kinematic, and dynamic
7.5 Scale effect in models
7.6 Formation of dimensionless equations by Buckingham's method

**8 Fluid Machineries (9 hours)**

8.1 Classification of fluid machines

8.2 Water turbine: Classification, Pelton, Francis, and Kaplan turbine (Working principles, components, and their functions)
8.3 Water pump: Classification, centrifugal, and reciprocating pump (Working principles, components, and their functions)
8.4 Specific speed, efficiency, and cavitation in pumps and turbines
8.5 Characteristic curves and selection of turbines and pump
8.6 Miscellaneous fluid devices: Hydraulic press, hydraulic lift, torque converter, hydraulic crane

**Tutorial** **(15 hours)**

1. Calculation of fluid properties, viscosity, surface tension
2. Pressure and pressure measuring devices: Manometer
3. Continuity equations, Bernoulli's equations, and its application
4. Major head loss, minor head loss in pipe fittings, pipe flow network
5. Notches and weirs, flow measurement devices
6. Dimensional analysis using Buckingham's method
7. Turbine and pump power equation and efficiency

**Practical** **(22.5 hours)**

1. Viscosity measurement
2. Reynold's experiment
3. Determination of stability of floating objects
4. Comparison of force due to the impact of a jet on a moving body
5. Determination of loss coefficient of pipe fittings on pipe flow network
6. Plot of hydraulic and energy grade lines: pipe, Venturi meter
7. Measurement of lift and drag forces on objects of different shapes
8. Determination of discharge coefficient: orifice, Venturi meter, notch
9. Demonstration of the working of the water turbine
10. Demonstration of the working of the water pump

**Final Exam**

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

| Chapters | Hours | Marks distribution* |
|---|---|---|
| 1 and 8 | 11 | 12 |
| 2 | 7 | 12 |
| 3 | 10 | 12 |
| 4 and 5 | 8 | 12 |
| 6 and 7 | 9 | 12 |
| **Total** | **45** | **60** |

* There may be minor deviation in marks distribution.

**References**


1. Fox, R. W, McDonald, A. T., Pritchard, P. J., (2011). Introduction to Fluid Mechanics. John Wiley & Sons, Inc.
2. Douglas, J. F., Gasoriek, J. M., Swaffield, J., Jack, L. (2006). Fluid Mechanics. Prentice Hall.
3. Robert L. Daugherty, Joseph B. Franzini and E. John Finnemore (1977). Fluid Mechanics with Engineering Applications (7th ed.). McGraw Hill Book Company, SI Metric Edition.
4. Massey, B.S. (2006). Fluid mechanics (4th ed.). Taylor & Francis Taylor & Francis Group London and New York.
5. White, F. M. (2011). Fluid Mechanics. McGraw-Hill
6. Streeter, V. L., Benjamin W. E., Bedford, K.W. (2011). Fluid Mechanics. Tata McGraw Hill Publishing Co Ltd., New Delhi, India.
7. Bansal, R.K. (2010). A Textbook of Fluid Mechanics and Hydraulic Machines. Laxmi Publications, New Delhi.
8. Som, S. K., Biswas, G. (2012). Introduction to Fluid Mechanics and Fluid Machines. Tata McGraw Hill, New Delhi
9. Khan, M.K. (2015). Fluid Mechanics and Machinery. Oxford University Press.