# CHAPTER 1. Fluids and their Properties

1. Explain following terms in detail:
    a. Density or Mass Density
    b. Weight Density or Specific Weight
    c. Specific Gravity or Relative Density
    d. Specific Volume
    e. Viscosity or Dynamic Viscosity
    f. Kinematic Viscosity
    g. Capillary Effect
    h. Compressibility and Bulk Modulus
    i. Cavitation
    j. Vapour Pressure
2. Give Classification of Fluid.
3. Give Difference between Solid and Fluid.
4. Define surface tension. Derive an expression for surface tension for the following cases:
    a. Water droplet
    b. Hollow bubble
    c. Liquid jet
5. A 50 mm diameter shaft rotates with 500 rpm in a 80 mm long journal bearing with 51 mm internal diameter. The annular space between the shaft and bearing is filled with lubricating oil of dynamic viscosity 1 poise. Determine the torque required and power absorbed to overcome friction.
6. The pressure outside the droplet of water of diameter 0.05 mm is 1.0132 $N/cm^2$ (atmospheric pressure). Calculate the pressure within the droplet if surface tension is given as 0.073 N/m of water.

# CHAPTER 2. Pressure and Head

1. Define the pressure. State and prove the Pascal's law and also mention its application.
2. Prove that "Intensity of pressure at any point in a fluid at rest is same in all direction".
3. Derive an equation of pressure variation with respect to vertical axis in a fluid under the gravity.
4. Explain following with neat sketch:
    a. Diaphragm pressure gauge
    b. Bourdon tube pressure gauge
    c. Dead weight pressure gauge
    d. Bellows pressure gauge
5. A hydraulic press has a ram of 50 cm diameter and plunger of 10 cm diameter. The plunger has a stroke of 48 cm and it executes 100 strokes per minute. Calculate the force to be applied at the plunger to lift a load of 30kN. Also calculate power required in driving the plunger.
6. The pressure intensity at a point in a fluid is 4.905 $N/cm^2$. Calculate the corresponding height of fluid in terms of (i) water (ii) oil specific gravity 0.8 (iii) mercury specific gravity 13.6.

# CHAPTER 3. Static Forces on Surface and Buoyancy

1. Derive the expression for total pressure and centre of pressure for a vertical plate submerged in the liquid with usual notations.
2. Define Buoyancy force, Centre of Buoyancy, Metacentre and Metacentric height. Also describe conditions of equilibrium for floating and submerged bodies.
3. A rectangular plate 2m wide and 5m long is immersed in water in such a way as (i) Horizontally 1m below the free surface of water (ii) Vertically 2m side is parallel to the water surface and 1m below the free surface of water. Find (a) Total pressure on the plate (b) Position of centre of pressure.
4. A circular lamina 125 cm in diameter is immersed in water so that the distance of its edge measured vertically below the free surface varies 60 cm to 150 cm. Find the total force due to water on one side of the lamina and vertical distance of the centre of pressure below the water surface.
5. A tank contains water upto a height of 300 mm above the base. An immiscible liquid of specific gravity 0.9 is filled above the water upto a height of 600 mm. Determine (i) Pressure at the bottom of the tank, (ii) the total pressure and (iii) the position of centre of pressure on the one side of the tank. Take width of tank is 2m.
6. A solid cylinder of diameter 4m has a height of 4m. Find the metacentric height of the cylinder if the specific gravity of the material of cylinder is 0.7 and it is floating in water with its axis vertical. State whether the equilibrium is stable or unstable.

# CHAPTER 4. Motion of fluid particles and Streams

1. Explain various types of fluid flow.
2. Derive an expression for continuity equation for three dimensional flow and reduce it for steady, incompressible 2-D and 3-D flow in Cartesian co-ordinate system.
3. Explain the following in brief:
    a. Total acceleration, Convective acceleration & Local acceleration.
    b. Stream line, Path line & Streak line.

# CHAPTER 5. The Energy Equation and its Application

1. Derive Euler's equation of motion along a stream line and hence obtain Bernoulli's equation. Also state Bernoulli's theorem with its assumptions.
2. Explain Venturimeter in brief. Derive an expression for discharge through venturimeter.
3. What is Pitot tube? Derive an expression for the measurement of velocity of flow at any point in a pipe by pitot tube.
4. Derive an expression for discharge over Triangular notch.
5. Derive an expression for discharge over Rectangular notch.
6. Define following terms:
    a. Kinetic energy correction factor
    b. Momentum energy correction factor
7. A pipe line carrying oil of specific gravity 0.9, changes in diameter from 250 mm diameter at a position 1 to 450 mm diameter at a position 2 which is 6 m at a higher level. If the pressure at 1 and 2 are 12 $N/cm^2$ and 6 $N/cm^2$ respectively and the discharge is 250 liters/s. Calculate the loss of head and direction of flow.
8. A horizontal venturimeter with inlet diameter 150 mm and throat diameter 75 mm is employed to measure the discharge of water. The differential manometer connected to the inlet gives reading of 150 mm of mercury. Determine the rate of flow if the coefficient of discharge is 0.98.
9. The head of water over an orifice of diameter 7.5 cm is 7.5 m. The jet of water coming out from the orifice is collected in a tank having cross-sectional area of 1 m × 1 m. The rise of water level in this tank is 0.87 m in 25 seconds. The co-ordinates of a point on the jet measured from vena-contracta are 3.75 m horizontal and 0.5 m vertical. Find the co-efficient of discharge, co-efficient of velocity and co-efficient of contraction.
10. A flat plate is shrunk normally by a jet of water 50 mm diameter with a velocity of 18 m/s. Calculate (i) the force on the plate when it is stationary, (ii) the force on the plate when it moves in the same direction as the jet with a velocity of 6 m/s (iii) the work done per second in case (ii).

# CHAPTER 6. Two-Dimensional Ideal fluid flow

1. Explain the following in brief:
    a. Velocity potential function & Stream function
    b. Vorticity
2. Prove that equipotential line and stream line are perpendicular to each other.
3. Define Circulation. Prove that circulation $\Gamma = \int \xi dA$
4. Define flow net. Also describe the use and limitations of flow net.
5. Define vortex flow. Also derive expressions of potential function and stream function for vortex flow.
6. Differentiate between free and forced vortex flow.

# CHAPTER 7. Dimensional Analysis and Similarities

1. State Buckingham's π-theorem. What do you mean by repeating variables? How the repeating variables are selected in dimensional analysis?
2. State the various dimensionless numbers with their significance in fluid flow situations. Explain Froude, Euler and Weber model law with applications.
3. Discuss different types of similarities that must exist between a prototype and its model.
4. The resistance R to the motion of a completely submerged body depends upon the length of the body, velocity of flow, mass density and kinematic viscosity. Deduce the relationship between R and other variables by using Rayleigh's method.
5. The pressor drop in pipe (ΔP) depends upon (1) mean velocity of flow(v), (2) diameter of pipe(d), (3) length of pipe (l), (4) roughness inside the pipe (k), (5) viscosity of fluid (μ), and (6) density of fluid(ρ). Using Buckingham's π-theorem, obtain dimensionless expression for ΔP. Also show that $h_f = \frac{4flv^2}{2gd}$

# CHAPTER 8. Viscous Flow

1. For the viscous flow through circular pipe show that the velocity distribution across the section is parabolic also prove that the mean velocity is equal to one half the maximum velocity.
2. Derive the expression for Hagen-Poiseuille's formula.
3. Obtain expression for the power required to overcome the viscous resistance of Journal bearing and Foot-step bearing.
4. Explain falling sphere resistance method to determine the co-efficient of viscosity.
5. Explain (i) Say Bolt Viscometer (ii) Redwood viscometer.
6. The viscosity of a liquid is measured by rotating cylinder viscometer, in which case the inner cylinder of diameter 30 cm is stationary. The outer cylinder of diameter is 30.5 cm, contains the liquid up to a height of 40 cm. The clearance at the bottom of the two cylinders is 0.5 cm. The outer cylinder is rotated at 300 rpm. The torque registered on the torsion meter attached to the inner cylinder is 6 N.m. Determine the viscosity of fluid.
7. Two parallel plates 80 mm apart have laminar flow of oil between them with maximum velocity of flow is 1.5 m/s. Calculate (i) Discharge per meter width (ii) Shear stress at the plate (iii) The difference in the pressure between two points 20 meter apart (iv) Velocity gradient at the plates (v) Velocity at 20 mm from the plate. Assume viscosity of oil 24.5 poise.

# CHAPTER 9. Turbulent Flow

1. Derive an expression for loss of head due to friction in pipe flow with usual notation.
2. What do you understand by the terms major energy loss and minor energy losses in pipe?
3. Write a short note on moody diagram for calculating the head loss due to friction.

# CHAPTER 10. Flow through Pipes

1. Derive the expression for Darcy-Weisbach formula for friction loss in pipe.
2. Explain total energy line (T.E.L) and hydraulic gradient line (H.G.L).
3. Derive the expression for maximum efficiency corresponding to the maximum power transmitted for flow through the pipes.
4. Explain equivalent pipe and Syphon.
5. An oil of viscosity 0.5 stoke is flowing through a pipe of 30 cm diameter at a rate of 320 litres per second. Find the head loss due to friction for the pipe length of 60 m.
6. A diverging duct PQ, the diameter at P and Q are 20 cm and 40 cm respectively, in which water flows at the rate of 0.2 $m^3$/s. The pressure head at P is 6 m of water and its elevation above the ground is 2 m. The point Q is 4 m above the ground. If frictional losses are 1.5 m, find the pressure at point Q and draw HGL and TEL.

# CHAPTER 11. Compressible Flow

1. Prove that velocity of sound wave in a compressible fluid is given by $c = \sqrt{\frac{k}{\rho}}$ where k = Bulk modulus of fluid and ρ = Density of fluid.
2. Explain Zone of action, Zone of silence, Mach angle, Mach number and Mach-cone with the help of diagram.
3. Derive an expression for the velocity of sound wave in a compressible fluid in terms of change of pressure and change of density.
4. A projectile is travelling in air having pressure and temperature as 0.1 N/mm$^2$ and 0°C. The mach angle is 38°. Calculate the velocity of the projectile. Assume ϒ=1.4 and R=0.287 kJ/kg.K.
5. A supersonic aeroplane is flying at 1500 km/hr at an altitude of 10 km above sea level in standard atmosphere. The pressure and density are as 2.5 N/cm$^2$ absolute and 0.4 kg/m$^3$. Calculate the pressure, temperature and density at the stagnation point on the nose of the plane. Assume R=287 J/kg.K and ϒ=1.4.