QUESTION BANK

CHAPTER 1: FLUIDS AND THEIR PROPERTIES

1	Discuss SI, MKS and CGS units of Dynamic Viscosity and Kinematic Viscosity.
2	If the velocity distribution over a plate is given by $$u = \frac{5}{6}y - y^2$$ in which u is the velocity in meter per second at a distance y meter above plate, determine the shear stress at $\boldsymbol{y} = \mathbf{0}$ and $\boldsymbol{y} = \mathbf{0.20}$ m. Take dynamic viscosity of fluid as 8.63 poises.
3	The space between two square flat parallel plates is filled with oil. Each side of the plate is 50 cm. The thickness of the oil film is 10 cm. The upper plate, which moves at 2.5 meter per sec requires a force of 98.1 N to maintain the speed. Determine: (i) the dynamic viscosity of the oil in poise and (ii) the kinematic viscosity of the oil in stokes if the specific gravity of the oil is 0.95.
4	The dynamic viscosity of oil, used for lubrication between a shaft and sleeve is 6 poise. The shaft is of diameter 0.45 m and rotates at 200 r.p.m. Calculate the power lost in the bearing for a sleeve length of 90 mm. The thickness of the oil film is 1.85 mm.
5	A vertical gap 2.1 cm wide of infinite extent contains a fluid of viscosity 2.0 Ns/m^2 and specific gravity 0.9. A metallic plate 1.15 m X 1.15 m X 0.15 m is to be lifted up with a constant velocity of 0.13 m/sec, through the gap. If the plate is in the middle of the gap, find the force required. The weight of the plate is 35 N.
6	A cylinder of 0.55 m3 in volume contains air at 45^0 C and 0.25 N/mm^2 absolute pressure. The air is compressed to 0.25 m^3. Find (i) pressure inside the cylinder assuming isothermal process and (ii) pressure and temperature assuming

	adiabatic process. Take k = 1.4.
7	What is the bulk modulus of elasticity of a liquid which is compressed in a cylinder from a volume of 0.0124 m^3 at 75 N/cm^2 pressure to a volume of 0.0122 m^3 at 145 N/cm^2 pressure?
8	An oil of viscosity 5 poise used for lubrication between a shaft and sleeve. The diameter of the shaft is 0.45 m and it rotates at 210 rpm. Calculate the power lost in oil for a sleeve length of 105 mm. The thickness of oil film is 1.1 mm.

CHAPTER 2 STATIC FORCES ON SURFACE AND BUOYANCY

1	Explain force on a curved surface due to hydrostatic pressure. Derive an expression of resulting horizontal, vertical and resultant force on a curved surface immersed in a liquid.
2	Define total pressure and centre of pressure.
3	Derive the expression for total pressure and centre of pressure for a vertical plate submerged in liquid with usual notations.
4	Explain the conditions of stability for a submerged and floating body with neat diagrams.
5	Prove that the centre of pressure for any immersed surface always lies below its centroid.
6	Distinguish between centre of pressure and centre of gravity.
7	Define: Force on buoyancy, metacentre, centre of buoyancy and metacentric height.
8	Explain the conditions of stability for submerged body.
9	Show that the distance between the metacentre and centre of buoyancy is given by $BM = \frac{I}{V}$.

CHAPTER 3: MOTION OF FLUID PARTICLES AND STREAMS

1	Derive continuity equation in 3 dimensional coordinate system.
2	Explain briefly: Steady and unsteady flow, uniform and non-uniform flow and Laminar and turbulent flow.
3	Distinguish between forced vortex and free vortex flow.
4	Explain flow-net and state the importance of flow net.
5	Distinguish between rotational and irrotational flow.
6	Define circulation and prove its equation.
7	Explain the term vorticity.

CHAPTER 4: THE ENERGY EQUATION AND ITS APPLICATION

1	Derive an expression for the discharge through a venturimeter and compare it with orifice meter for measurement of flow through orifice.
2	Derive expression for discharge over rectangular notch.
3	Derive an expression for Bernoulli's theorem and write the assumptions made in it.
4	Define coefficient of discharge and coefficient of velocity.
5	Derive an expression for the discharge of water over a V-notch (or Triangular notch) with usual notations.
6	Derive Euler's equation of motion along a stream line.
7	What is pitot tube? How is it used to measure the velocity of flowing water in a pipe?
8	Explain vena- contracta. Discuss the characteristics of flow at venaontracta, in case of orifice.
9	Explain momentum principle. What are its applications?

CHAPTER 5: DIMENSIONAL ANALYSIS AND SIMILARITIES

1	State the dimensional homogeneity. Prove that the following equations are homogeneous equations: (i) $Q = AV$ (ii) $T = 2\pi\sqrt{\frac{L}{g}}$ (iii) $V = \sqrt{2gH}$
2	Using Buckingham's π-theorem, show the efficiency η of a fan depends on density ϱ, dynamic viscosity μ of fluid, angular velocity ω, diameter D of the rotor and the discharge Q.
3	Using Buckingham's π-theorem, show that the velocity through a circular orifice given by $$V = \sqrt{2gH}\ \emptyset\left[\frac{D}{H}, \frac{\mu}{\rho V H}\right]$$ Where H is head causing flow, D is the diameter of the orifice, μ is the coefficient of viscosity, ϱ is mass density and g is the acceleration due to gravity.
4	The frictional torque T of a disc of diameter D rotating at a speed of N in a fluid of viscosity μ and density ϱ in a turbulent flow is given by, $$T = D^5 N^2 \rho\ \varphi\left[\frac{N}{D^2 N \rho}\right]$$ Prove this by Buckingham's π-theorem.
5	The resistance R to the motion of completely submerged body depends on length of body, velocity of flow, mass density and kinematic viscosity. Find the relation between R and other variables using suitable method.
6	The lift force F_L on the air foil depends upon the mass density ϱ of the medium, velocity of flow V, characteristic length d, the viscosity μ and the angle of attack α. Obtain an expression for lift force by using Buckingham's π-theorem.

7	Prove that the scale ratio for discharge for a distorted model is given as $$\frac{Q_p}{Q_m} = (L_r)_H (L_r)_V{}^{1.5}$$
8	The resisting force R of a supersonic plane during flight can be considered as dependent on the length of aircraft l, velocity V, viscosity of air μ, air density ϱ and bulk modulus of air K. Express the functional relationship between these variables with the resisting force.
9	The efficiency of fan depends upon diameter of rotor, discharge of fluid, density of fluid, dynamic viscosity of fluid and angular velocity of rotor. Find the expression for efficiency in terms of dimensionless number.
10	The pressure difference Δp in a pipe of diameter d and length L due to viscous flow, depends on velocity v, viscosity μ and density ϱ. Using Buckingham's π-theorem, obtain an expression of Δp.
11	Show, using Buckingham's π-theorem, that the resistance (F) to the motion of a sphere of diameter D moving with a uniform velocity V through a real fluid of density ϱ and viscosity μ is given by $$F = \rho D^2 V^2 \varphi\left[\frac{\mu}{\rho V D}\right]$$

CHAPTER 6: VISCOUS AND TURBULENT FLOW

1	State the different observations in Reynolds experiment for various states of flow.
2	Prove that the average velocity is half of the maximum velocity in circular pipe with steady laminar flow.
3	Derive an expression for the velocity distribution for viscous flow through a circular pipe. Also sketch the velocity distribution and shear stress distribution across a section of the pipe. Using that prove that the ratio of maximum velocity to average velocity is 2.
4	Derive an expression for the Hagen Poiseuille's formula.
5	Derive an expression for power absorbed in foot step bearing.
6	Derive Darcy-Weisbach equation.
7	Explain the term coefficient of friction. On what factors does this co-efficient depend?
8	Obtain an expression for the coefficient of friction in the terms of shear stress.
9	Obtain expression for the velocity distribution for turbulent flow in smooth pipes.
10	Show that velocity distribution for turbulent flow through rough pipe is given by $$\frac{u}{u_*} = 5.75\ \log_{10}\left(\frac{y}{k}\right) + 8.5$$ Where u_* = shear velocity, y = distance from pipe wall, k = roughness factor
11	Write a short note on moody diagram for calculating the head loss due to friction.

CHAPTER 7: FLOW THROUGH PIPES

1	State the momentum correction factor and list the momentum correction factor for different flow in pipes.
2	Prove the friction head losses is equal to one third of total head at inlet for maximum power transmission through pipe.
3	Derive expression for the loss of head due to friction in pipes.
4	What do you understand by frictional resistance offered by pipe?
5	Derive an equation for loss of head due to sudden enlargement.
6	Write a short note on Water Hammer in Pipes.

CHAPTER 8: IMPACT OF JET AND HYDRAULIC TURBINES

1	Prove that the velocity of the vanes should be half the velocity of jet for maximum efficiency for a series of flat vanes held normal to the axis of jet.
2	Derive an expression for calculating efficiency for radial vane for jet striking a moving curved vane tangentially at one tip.
3	Show that when a jet of water impinges on a series of curved vanes maximum efficiency is obtained when the vane is semi-circular and the velocity of jet is double the velocity of vane.
4	Explain impulse momentum principle.
5	Calculate the force and work-done when jet strikes moving vertical and inclined flat plate.
6	Explain construction and working of Pelton wheel turbine. Derive an expression for maximum hydraulic efficiency of Pelton wheel.
7	Describe with sketch the working of governing system of Francis turbine.
8	State the functions of a draft tube and explain with neat sketches different types of draft tubes.
9	How are hydraulic turbines are classified?
10	State causes of cavitation in hydraulic turbine and methods of avoiding it.
11	State advantages and disadvantages of Francis turbine over Pelton wheel.
12	Sketch and describe a modern method of regulation to maintain constant speed for Pelton turbine. Explain the performance characteristics of Pelton turbine.
13	Explain construction and working of Kaplan turbine with neat sketch.
14	Explain criteria for the selection of hydraulic turbines.
15	Explain hydraulic efficiency, mechanical efficiency and overall efficiency with expression.
16	Define specific speed of a turbine and derive an expression for the same.

CHAPTER: 9 CENTRIFUGAL PUMPS

1	Give classification of centrifugal pump.
2	Derive expression for the pressure rise in the impeller of a centrifugal pump by neglecting the frictional and other losses in the impeller.
3	Discuss the various characteristic curves of a centrifugal pump.
4	Explain the following terms: Net positive suction head, priming and cavitation.

CHAPTER: 10 HYDRAULIC MACHINES

	Explain construction and working of the followings with neat sketch:
1	Hydraulic Ram
2	Hydraulic Intensifier
3	Air lift pump
4	Hydraulic torque converter
5	Hydraulic press
6	Hydraulic accumulator
7	Hydraulic crane