RVK/KW/13/6581/6607

Faculty of Engineering & Technology

Third Semester B.E. (Mech./Power Engg.) (C.B.S.)

Examination

FLUID MECHANICS

Time—Three Hours] [Maximum Marks—80

INSTRUCTIONS TO CANDIDATES

(1) All questions carry marks as indicated.

(2) Solve **SIX** questions as follows :

Que. No. 1 **OR** Que. No. 2, Que. No. 3 **OR** Que. No. 4, Que. No. 5 **OR** Que. No. 6, Que. No. 7 **OR** Que. No. 8, Que. No. 9 **OR** Que. No. 10, Que. No. 11 **OR** Que. No. 12

(3) Due credit will be given to neatness and adequate dimensions.

(4) Illustrate the answers with necessary figures/ drawings, if required.

(5) Use of Drawing instruments is permitted.

(6) Use of non-programmable calculator is permitted.

(7) Assume suitable data wherever necessary.

1. (a) Define the following terms :

(i) Newton's law of viscosity

(ii) Surface Tension

(iii) Compressibility. 6

(b) An oil of viscosity 5 poise is used for lubrication between a shaft and sleeve. The diameter of shaft is 0.5 m and it rotates at 200 r.p.m. Calculate the power lost in the oil for a sleeve length of 100 mm. The thickness of oil film is 1.0 mm. 7

OR

2. (a) Define the following terms :

(i) Steady and unsteady flow

(ii) Rotational and irrotational flow

(iii) Path line and streak line. 6

(b) The velocity vector in a fluid flow is given by $V = 2x^3i - 5x^2yj + 4tk$. Find the velocity and acceleration of a fluid particle at (1, 2, 3) at time $t = 1$. 7

3. (a) A simple 'U'-tube manometer containing mercury is connected to a pipe in which an oil of sp. gravity 0.8 is flowing. The pressure in the pipe is vacuum. The other end of the manometer is open to the atmosphere. Find the vacuum, pressure in pipe, if the difference of mercury level

in the two limbs is 20 cm and the height of oil in the left limb from the centre of the pipe is 15 cm below. 7

(b) Find the total pressure and position of centre of pressure on a triangular plate of base 2 m and height 3 m which is immersed in water in such a way that the plane of the plate makes an angle of 60° with the free surface of water. The base of plate is parallel to water surface and at a depth of 2.5 m from water surface. 6

OR

4. (a) A roller gate is shown in Fig. 1. It is in cylindrical form with 6 m diameter. It is placed on the dam. Find the magnitude and direction of the resultant force due to water acting on the gate when the water is just going to spill. The length of the gate is 10 m. 6

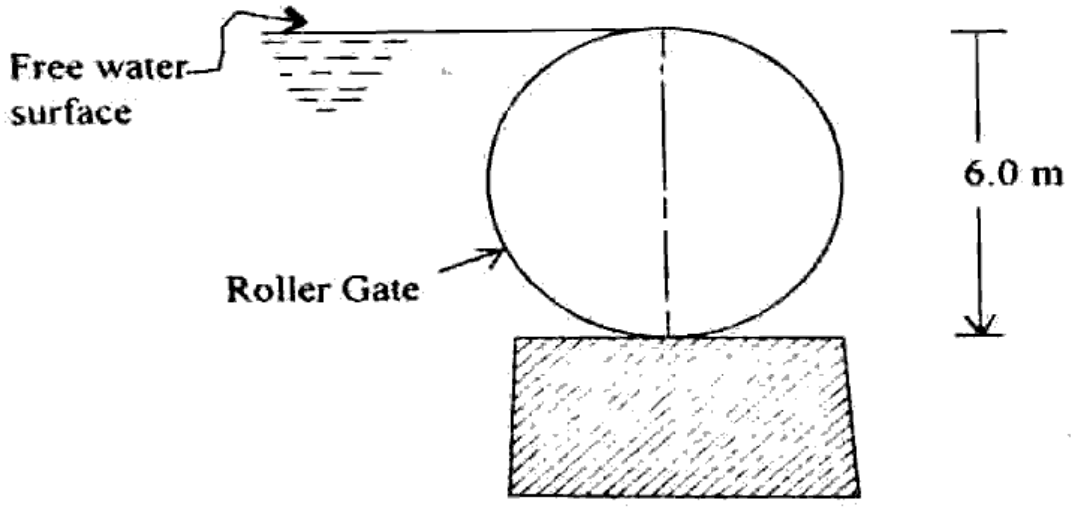

Fig. 1

(b) A cylindrical buoy is 2 m in diameter, 2.5 m long and weighs 2.2 metric tonnes. The density of sea water is 1025 kg/m^3. Show that the body cannot float with its axis vertical. 7

5. (a) Derive an expression for rate of flow through venturimeter. 7

(b) A horizontal venturimeter with inlet diameter 30 cm and throat diameter 15 cm is used to measure the flow of oil of sp.gr. 0.8. The discharge of oil through venturimeter is 50 litres/s, find the reading of oil-mercury differential manometer. Take $C_d = 0.98$. 7

OR

6. (a) An orifice meter with orifice diameter 15 cm is inserted in a pipe of 30 cm diameter. The pressure difference measured by mercury oil manometer on two sides of the orifice meter gives a reading of 50 cm of mercury. Find the rate of flow of oil of sp. gravity 0.9, when coefficient of discharge of meter is 0.64. 7

(b) A tank 1 m × 1 m in area has a 20 mm diameter orifice at its bottom. Initially the depth of water is 4 m. Find the time taken for the water surface to drop by 1 m. Further what time is taken for a fall of 1 m of the water surface ? Take $C_d = 0.62$. 7

7. (a) A fluid of viscosity 0.7 Ns/m² and specific gravity 1.3 is flowing through a circular pipe of diameter 100 mm. The maximum shear stress at the pipe wall is given as 196.2 N/m². find (a) the pressure gradient, (b) the average velocity and (c) Reynold's number of the flow. 6

(b) A shaft having a diameter of 50 mm rotates centrally in a journal bearing having a diameter of 50 mm and length 100 mm. The angular space between the shaft and the bearing is filled with oil having viscosity of 0.9 poise. Determine the power absorbed in the bearing when speed of rotation is 60 r.p.m. 7

OR

8. (a) Determine the dimensions of the quantities given below :

(i) Angular velocity

(ii) Angular Acceleration

(iii) Discharge

(iv) Kinematic viscosity

(v) Dynamic viscosity

(vi) Specific weight. 6

(b) Using Buckingham's π-Theorem, show that the velocity through a circular orifice is given by $V = \sqrt{2gH}\,\phi\left[\frac{D}{H}, \frac{\mu}{\rho VH}\right]$. where H is head causing flow, D is the diameter of the orifice, μ is coefficient of viscosity, ρ is the mass density and g is acceleration due to gravity. 7

9. (a) The difference in water surface levels in two tanks, which are connected by three pipes in series of lengths 300 m, 200 m and 170 m and of diameters, 300 mm, 250 mm and 350 mm respectively, is 12 m. Determine the rate of flow of water if coefficient of friction are .005, .0052 and .0048 respectively, considering (i) minor losses, (ii) neglecting minor losses. 7

(b) A horizontal pipe line 40 m long is connected to water tank at one end and discharges freely into the atmosphere at the other end. For the first 25 m of its length from tank, the pipe is 150 mm in diameter and its diameter is suddenly enlarged to 300 mm. The height of water level in the tank is 8 m above the centre of pipe. Considering all losses of head which occur, determine the rate of flow. Take f = 0.01 for both sections of pipe. 6

OR

10. (a) A syphon of diameter 200 mm connects two reservoirs having a difference in elevation of 20 m. The length of syphon is 500 m and summit is 3 m above the water level in the upper reservoir. The length of the pipe from upper reservoir to summit is 100 m. Determine the discharge through the syphon and also pressure at summit. Neglect minor losses. Assume coefficient of friction $f = 0.005$. 7

(b) 75 kW power is to be transmitted, the pressure at inlet of pipe being 7000 kPa. If pressure drop per kilometer is 43 kPa and if $f = 0.006$, find the diameter of the pipe and efficiency of transmission for 16 kilometers. 6

11. (a) Find the displacement thickness, the momentum thickness and energy thickness for the velocity distribution in the boundary layer given by $\frac{u}{U} = \frac{y}{\delta}$, where u is the velocity at a distance y from the plate and $u = U$ at $y = \delta$, where δ = boundary layer thickness. Also calculate the value of $\frac{\delta^*}{\theta}$. 7

(b) A flat plate 1.5 m × 1.5 m moves at 50 km/hour in stationary air of density 1.15 kg/m³. If the coefficients of drag and lift are 0.15 and 0.75 respectively, determine :

(i) The lift force

(ii) The drag force

(iii) The resultant force

(iv) Power required to keep the plate in motion. 7

OR

12. Write short notes on (any **THREE**) :

(i) Drag and Lift

(ii) Streamline and Bluff Body

(iii) Laminar flow over a plate

(iv) Boundary layer concept. 14