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BME-028

B.Tech. MECHANICAL ENGINEERING (COMPUTER INTEGRATED MANUFACTURING)

01300

Term-End Examination

June, 2015

BME-028 : FLUID MECHANICS

Time : 3 hours *Maximum Marks : 70*

Note : *Answer any* ***seven*** *questions. Use of scientific calculator is permitted. All questions carry equal marks.*

1. (a) State the Newton's law of viscosity and determine the dynamic and kinematic viscosities of the oil between the flat plates, if one plate is fixed and another plate 0·025 mm distant from fixed plate moves at 50 cm/s and requires a force of 1·47 N/m^2 to maintain this speed. The specific gravity of the oil is 0·95.

(b) A wooden cylinder of specific gravity 0·6 and circular in cross-section is required to float in oil of specific gravity 0·8. Find the maximum L/D ratio for the cylinder to float with its longitudinal axis vertical in oil, where L is the height of the cylinder and D is its diameter. *5+5=10*

2. (a) Distinguish between any ***two*** of the following :

(i) Rotational and Irrotational flow;

(ii) Compressible and Incompressible flow;

(iii) Pathline and Streakline.

(b) A cubical tank has sides of 1·5 m. It contains water for a lower 0·6 m depth. The upper remaining part is filled with oil of specific gravity 0·90. Calculate the total pressure and position of centre of pressure for one vertical wall of the tank. *5+5=10*

3. (a) Define two-dimensional stream function and velocity potential. Check if $\phi = x^2 - y^2 + y$ represents the velocity potential for 2-dimensional irrotational flow. If it does, then determine the stream function ψ.

(b) Derive Euler's equation of motion along a stream line for an ideal fluid, stating clearly the assumptions. *5+5=10*

4. (a) An open circular vessel of 12 cm diameter and 30 cm depth is filled with water up to the top. The vessel is rotated about its vertical axis with a velocity of 450 rpm. Find the quantity of water left in the vessel after rotation.

(b) A pipe of 300 mm diameter conveying 0·30 m^3/s of water has a right angled bend in a horizontal plane. Find the resultant force exerted on the bend, if the pressure at inlet and outlet of the bend are 24·5 N/cm^2 and 23·5 N/cm^2 respectively. *5+5=10*

5. (a) What is meant by velocity of approach ? How does the velocity of approach affect the discharge over a weir ?

(b) A discharge of 1500 m^3/s is to pass over a rectangular weir. The weir is divided into a number of openings, each of span 7·5 m. If the velocity of approach is 3 m/s, find the number of openings needed so that the head of water over the crest does not exceed 1·8. *5+5=10*

6. (a) Define the terms 'kinetic energy correction factor' and 'momentum correction factor'. Prove that for viscous flow through a circular pipe the kinetic energy correction factor is equal to 2.

(b) A laminar flow is taking place in a pipe of diameter 200 mm. The maximum velocity is 1·5 m/s. Find the mean velocity and the radius at which this occurs. Also calculate the velocity at 4 cm from the wall of the pipe. *5+5=10*

7. (a) What do you mean by the terms 'major energy losses' and 'minor energy losses' in pipes ? Obtain an expression for head loss in a sudden expansion in the pipe. List all the assumptions made in the derivation.

(b) A horizontal pipe line 40 m long is connected to a water tank at one end and discharges freely into the atmosphere at the other end. For the first 25 m of its length from the 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 the pipe. Considering all losses of head which occur, determine the rate of flow. Take coefficient of friction, f = 0·01 for both sections of the pipe. *5+5=10*

8. (a) An old water supply distribution pipe of 300 mm diameter is to be replaced by two parallel pipes of smaller equal diameter having equal lengths and identical friction factor values. Find the diameter of the new pipe.

(b) State Buckingham's π theorem. The efficiency 'η' of a fan depends on density 'ρ', dynamic viscosity 'μ' of the fluid, angular velocity 'ω', diameter 'D' of the rotor and the discharge 'Q'. Express η in terms of dimensionless parameters. *5+5=10*

9. (a) Define and explain Reynolds' number, Euler's number and Weber's number. Derive expressions for any one of the above numbers.

(b) Define the terms : boundary layer, boundary layer thickness, drag, lift and momentum thickness. *5+5=10*

10. (a) A jet plane which weighs 30,000 N and has a wing area of 20 m^2 flies at a velocity of 288 km/hr. When the engine delivers 7400 kW, 60% of the power is used to overcome the drag resistance of the wing. Calculate the co-efficient of lift and co-efficient of drag for the wing. Take the density of air to be 1·21 kg/m^3.

(b) What do you mean by dynamic similarity ? Water is flowing through a pipe of diameter 40 cm at a velocity of 5 m/s. Find the velocity of oil flowing in another pipe of diameter 10 cm, if the condition of dynamic similarity is satisfied between the two pipes. The viscosity of water is 0·01 poise and that of oil is 0·025 poise. The specific gravity of oil is 0·81. *5+5=10*
