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BIME-004

B.Tech. – VIEP – Mechanical Engineering / B.Tech. Civil Engineering (BTMEVI/BTCLEVI)

Term-End Examination

00200

June, 2016

BIME-004 : FLUID MECHANICS

Time : 3 hours *Maximum Marks : 70*

Note : *Attempt any **five** questions. All questions carry equal marks. Use of calculator is permitted.*

1. (a) State and prove Pascal's law and give some examples where this principle is applied. *6*

(b) A rectangular plate 3 m × 5 m is immersed vertically in water such that the 3 m side is parallel to the water surface. Determine the hydrostatic force and the centre of pressure, if the top edge of the surface is

(i) flush with the water surface,

(ii) 2 m below the water surface. *8*

2. (a) Define path line, streak line and the stream line. For what type of flow are these lines identical ? *6*

(b) The velocity components of a three-dimensional, incompressible fluid flow are described as

$$u = x^2 + z^2 + 5\,;\ v = y^2 + z^2 - 3.$$

Make calculations for the third component of velocity. Further check whether the flow is irrotational. *8*

3. (a) Derive Euler's equation of motion along a stream line, and hence derive the Bernoulli's theorem. *7*

(b) An air compressor draws air from the atmosphere through a bell-mouth entrance calibrated for measuring discharge passing through it in terms of height of water that rises in a single tube manometer installed in the duct which takes air from the bell-mouth to the compressor. Determine the flow rate of air through the bell-mouth, if the rise of water in the manometer tube is 25 cm and the duct has a diameter of 16 cm. For air density $\rho = 1{\cdot}2$ kg/m^3. *7*

4. (a) Deduce a formula for computing discharge through an orifice and mention the factors taken care of by the coefficient employed in it. 7

(b) A rectangular orifice, 1·25 m deep and 75 cm wide in the side of a tank, has its top edge 1 m below the free water surface in the tank. Find the discharge through the orifice. Take $C_d = 0{\cdot}6$. 7

5. (a) Define fundamental quantities, derived quantities and repeating variables. 7

(b) The efficiency of a fan depends on the density ρ, the dynamic viscosity μ of the fluid, the angular velocity ω, diameter D of the rotor and the discharge Q. Express the efficiency in terms of dimensionless parameters. 7

6. (a) Describe Reynolds experiments to demonstrate the laminar and turbulent fluid flows. How is the type of flow related to Reynolds number ? 6

(b) A container, full of oil, has a horizontal parallel crack in its end wall which is 500 mm wide and 50 mm thick in the direction of flow. The pressure difference between two faces of the crack is 10 kPa and the crack forms a gap of 0·4 mm between the parallel surfaces. Calculate

(i) the volume of oil leakage per hour through the crack,

(ii) maximum leakage velocity, and

(iii) shear stress and velocity gradient at the boundary. Take specific gravity and viscosity of oil equal to 0·85 and 1·8 poise respectively. *8*

7. (a) Explain the development of boundary layer along a thin flat and smooth plate held parallel to uniform flow. Point out the salient features. *7*

(b) Calculate the friction drag on a plate, 15 cm wide and 45 cm long, placed longitudinally in a stream of oil of specific gravity 0·925 and kinematic viscosity 0·9 stokes flowing with a free stream velocity of 6 metres per second. Also find the thickness of the boundary layer and shear stress at the trailing edge. *7*
