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BIME-004

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

00792

Term-End Examination

December, 2016

BIME-004 : FLUID MECHANICS

Time : 3 hours *Maximum Marks : 70*

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

1. (a) Explain the term total pressure acting on a plane surface immersed in a fluid at any angle. Obtain an expression for this, and also for the corresponding depth of the centre of pressure. 7

(b) A cylindrical buoy is 2 m in diameter and 2·5 m long and weighs 21·5 kN. The specific weight of sea water is 10 kN/m^3. Show that the buoy does not float with its axis vertical. What minimum pull should be applied to a chain attached to the centre of the base to keep the buoy vertical ? 7

2. (a) Define rotation as applied to fluid flow. Derive an expression for fluid rotation in a two-dimensional flow. 7

(b) The velocity distribution for a three-dimensional flow is

$$u = a + by - cz; \quad v = d - bx - ez;$$

$$w = f + cx - cy,$$

where a, b, c, d, e and f are arbitrary constants. Show that these are the velocity components of fluid motion. 7

3. (a) Show that the first law of thermodynamics (steady flow energy equation) for a streamline in a steady incompressible, frictionless flow is the same as Bernoulli's equation for such a flow. 7

(b) A pipeline conducts water from a reservoir to a power house, the elevation of which is 200 m lower than that of the surface of the reservoir. The water is discharged through a nozzle with a jet velocity of 60 m/s and at the nozzle exit the jet has a diameter of 20 cm. Make calculations for the power of the jet and the power lost in friction between the reservoir and the jet. 7

4. (a) Compare and contrast the use of venturimeter, flow nozzle and orifice meter as primary element for flow measurement. 7

(b) Determine the diameter of throat of a venturimeter to be introduced in a horizontal section of a 10 cm diameter main so that the reading of the differential U-tube manometer is 60 cm when the discharge is 20 litres per second. Assume the discharge coefficient of the meter as 0·95. 7

5. (a) What are the various methods of dimensional analysis to obtain a functional relationship between various parameters affecting a physical phenomenon ? Describe with an illustration. 7

(b) Show, by the use of Buckingham's π-theorem, that the velocity through an orifice given by

$$V = \sqrt{2gH}\ \phi\left(\frac{D}{H}, \frac{\mu}{\rho VH}, \frac{\sigma}{\rho V^2 H}\right),$$

where H is the head causing flow, D is the diameter of the orifice, μ is the coefficient, ρ is the mass density, σ is the surface tension and g is the gravitational acceleration. 7

6. (a) Establish a relation for the average and maximum velocity for one-dimensional viscous flow of fluid between two fixed parallel plates. 7

(b) A spindle, 5 cm in diameter, turns 110 revolutions per minute in a bearing 5·004 cm internal diameter. The intervening space is filled to 20 cm depth with a lubricating oil of dynamic viscosity 0·08 Pa.s. If the oil pressure is 4000 kPa, make calculations for the oil leakage along the spindle and the resisting torque due to viscous drag of the oil film. 7

7. (a) Define physically and mathematically the concept of displacement, momentum and energy thickness of a boundary layer. 7

(b) The velocity distribution in laminar boundary layer over a flat plate is assumed as

$$\mu = a \sin (by) + c,$$

where a, b and c are constants. Apply the appropriate boundary conditions and determine the velocity distribution law. 7