D 32963 (Pages : 3) Name.....

Reg. No.....

THIRD SEMESTER B.TECH. (ENGINEERING) DEGREE EXAMINATION DECEMBER 2012

Mechanical Engineering

ME/AM 04 303—FLUID MECHANICS

(2004 Addmissions)

Time : Three Hours Maximum : 100 Marks

Answer **all** *questions.*

1. (a) Define compressibility. Prove that compressibility for a perfect gas undergoing isothermal compression is $\frac{1}{P}$.

   (b) Express the pressure due to 0.5 mt. of (i) water ; (ii) oil of specific gravity 0.9 and mercury of specific gravity 13.6 in terms of N/m^2.

   (c) What are hydraulic coefficients ? Name them.

   (d) Write one dimentional Euler's equation along a stream line. Obtain Bernoulli's equation from it for incompressible fluids.

   (e) The following case represents the two velocity components. Determine the third component of velocity such that they satisfy the continuity equation

   $$U = x^2 + y^2 + z^2, \quad v = xy^2 - yz^2 + xy.$$

   (f) Distinguish between a source and a sink.

   (g) Define lift and drag force.

   (h) Discuss Prandtl mixing length theory.

   (8 × 5 = 40 marks)

2. (a) For an isothermal process, derive an expression for the pressure at a point in compressible fluid.

   (7 marks)

   (b) The circular plate of 3 m diameter having a concentric circular hole of 1.5 m diameter is immersed in water in such a way that its greatest and least depth below the free surface are 4 m and 1.5 m respectively. Determine the total pressure on one face of the plate and position of the centre of gravity.

   (8 marks)

Or

Turn over

3. (a) Derive an expression for the total force and depth of centre of pressure on an inclined plane surface submerged in the liquid.

(7 marks)

(b) A solid cone float in water with its apex downwards. Determine the least apex angle of the cone for stable equilibrium. The specific gravity of the material of the cone is given by 0.8.

(8 marks)

4. (a) Explain with a neat sketch the working of the Prandtl. tube. (7 marks)

(b) A pipeline carrying oil of sp.gravity 0.8 changes its diameter from 300 mm. at a position A to 500 mm. diameter to a position B which is 5 m at a higher level. If the pressure at A and B are 19.62 N/cm^2 and 14.91 N/cm^2 respectively and the discharge is 1.5 LPS. Find the loss of head and direction of flow.

(8 marks)

Or

5. (a) Derive Euler's equation of motion along a stream line. State all the assumptions. (7 marks)

(b) In, a 45° bend, a rectangular air duct of 1 m^2 cross-sectional area is gradually reduced to 0.5 m^2 area. Find the magnitude and the direction of the force required to hold the duct in that position, if the velocity of flow at the 1 m^2 section is 10 m/sec. and the pressure is 2.943 N/cm^2. Take density of air as 1.2 kg/m^3.

(8 marks)

6. (a) Explain minor losses and major losses in pipes. (7 marks)

(b) The velocity potential function (ϕ) is given by an expression $\phi = -\frac{xy^3}{3} - x^2 + \frac{x^3y}{3} + y^2$.

(i) Find the velocity components in x and y direction.

(ii) Show that ϕ represents a possible case of flow.

(8 marks)

Or

7. (a) Derive from first principles, the condition for irrotational flow. Prove that, for potential flow, both the stream function and velocity potential function satisfy the Laplace's equation.

(7 marks)

(b) Three pipes of the same length L, diameter D, and friction factor f are connected in parallel. Determine the diameter of the pipe of length L and friction factor f which will carry the same discharge for the same head loss.

(8 marks)

8. (a) Explain the development of boundary layer on a flat plate held parallel to the flow. (7 marks)

(b) A thin plate is moving in still atmospheric air at a velocity of 5 m/sec. The length of the plate is 0.6 m and width 0.5 m. Calculate (i) the thickness of the boundary layer at the end of the plate ; (ii) the drag force on one side of the plate. Take density of air as 1.24 kg/m^3 and kinematic viscosity 0.15 stokes.

(8 marks)

Or

9. (a) Obtain an expression for the boundary layer shear stress in terms of momentum thickness. (7 marks)

(b) Find the displacement thickness and momentum thickness for the velocity distribution in the boundary layer given by $\frac{u}{U} = 2\left(\frac{y}{\delta}\right) - \left(\frac{y}{\delta}\right)^2$.

(8 marks)

[4 × 15 = 60 marks]