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BIME-004

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

Term-End Examination

December, 2015

BIME-004 : FLUID MECHANICS

Time : 3 hours *Maximum Marks : 70*

Note : *Attempt any **five** questions. Assume missing data, if any, suitably. Use of calculator is permitted.*

1. (a) What is meant by intensity of pressure ? How does it vary with the depth of fluid ? *6*

(b) A rectangular pontoon 10 m long, 7·5 m wide and 2·5 m deep weighs 800 kN and floats in sea water (Specific Weight = 10 kN/m^3).

The pontoon carries on its upper deck a boiler 5 m in diameter and weighing 500 kN. The centre of gravity of each unit coincides with the geometrical centre of the arrangement and lies in the same vertical line. Compute the metacentric height. *8*

2. (a) Derive an expression for the period of oscillation of rolling of ship and then discuss its stability and comfort characteristics. *7*

(b) An open cylindrical vessel 1 m in diameter, and containing 750 litres of a liquid is rotated about its vertical axis. Find the smallest height the vessel should have, so that it can be rotated at 100 rpm without spilling any liquid over the sides. 7

3. (a) Differentiate between the Eulerian and Lagrangian method of representing fluid motion. 6

(b) Determine the velocity and acceleration of a particle at position x = 1, y =2 and z = 5 at time t = 0·1 in a velocity field prescribed by 8

$$\vec{V} = (x, y, z, t) = 10x^2 \vec{i} - 20yx \vec{j} + 100t \vec{k}.$$

4. (a) Define the stream function and clearly bring out its physical significance. Enumerate some of the salient features of the stream function. 7

(b) The velocity vector of a certain flow field is given by :

$$\vec{V} = y^2z^2 \vec{i} + z^2x^2 \vec{j} + x^2y^2 \vec{k}.$$

Find the equation of streamline for which the flow will always be irrotational in character. 7

5. (a) Derive Euler's equation of motion along a streamline. 7

(b) Water flows at the rate of 0·15 m^3/s through a 15 cm diameter orifice in a 30 cm diameter pipe. If the pressure gauges fitted upstream and downstream of the orifice indicate readings of 2 bar and 1 bar respectively, make calculations for the discharge coefficient for the orifice meter. 7

6. (a) Define the fundamental quantities, derived quantities and repeating variables. 6

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

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

where H is the head causing flow, D is the diameter of the orifice, μ is the coefficient of viscosity, ρ is the mass density, σ is the surface tension and g is the gravitational acceleration. 8

7. (a) What do you understand by the boundary layer ? Illustrate with reference to flow over a flat plate. *6*

(b) A thin flat plate 0·3 m wide and 0·6 m long is suspended and exposed parallel to air flowing with a velocity of 3 m/s. Calculate the drag force in both sides of the plate when the 0·3 m edge is oriented parallel to free stream. Consider flow to be laminar and assume that for air; $\nu = 0{\cdot}18$ stokes and $\rho = 1{\cdot}2$ kg/m^3. *8*