TCE-301 1222

Odd Semester Examination 2018-19

B. TECH (ME/CE/PPE/AE) (SEMESTER-III)

FLUID MECHANICS

Time: 03:00 Hours **Max Marks : 100**

Note : Attempt **ALL** questions. All Questions carry EQUAL marks. In case of numerical problems assume data whenever not provided. Don't write anything on the question paper except your roll no.

1. Attempt any **FOUR** of the following: [4× 5 = 20]

(a) What is capillarity? Derive expression for height of capillary rise.

(b) Derive expressions for total pressure and centre of pressure for a vertically immersed surface.

(c) State Buckingham's π–theorem. How repeating variables are selected by dimensional analysis? Write guidelines for selecting repeating variables.

(d) A crude oil of viscosity 0.9 poise and relative density 0.9 is flowing through a horizontal circular pipe of diameter 120 mm and length 12 m. Calculate the difference of pressure at the two ends of the pipe, if 785 N of the oil is collected in a tank in 25 seconds.

(e) Wind is blowing with a velocity of 120 km/h over a smooth two dimensional flat plate. If the laminar boundary layer exists upto a value of Reynolds number (R_{ex}) equal to 4×10^5. Find the maximum distance upto which laminar boundary layer persists and its maximum thickness. Assume kinematic viscosity of air as 1.49×10^{-5} m^2/sec.

2. Attempt any **FOUR** of the following: [4× 5 = 20]

(a) Consider a fluid of viscosity μ between two circular parallel plates of radii R separated by a distance h. Upper plate is rotated at an angular velocity ω, whereas bottom plate is held stationary. The velocity profile between two plates is linear. Find the torque experienced by bottom plate.

(b) A wooden block of relative density 0.7 has width 15 cm, depth 30 cm and length 150 cm. It floats horizontally on the surface of Sea water (density = 1000 kg/m^3). Find the metacentric height.

(c) Laboratory model of a river is built to a geometric scale of 1:100. The fluid used in the model is oil of ρ = 900 kg/m^3 and the highest flood in the river is 10000 m^3/s. Find the corresponding discharge in the model.

(d) Define Prandtl's mixing length and derive an expression for shear stress on the basis of 'Prandtl's Mixing Length Theory'.

(e) An aeroplane weighing 2200 N has a wing area of 22 m^2 and span of 12 m. What is the lift coefficient if it travels at a speed of 360 km/hr in the horizontal direction. Also compute the theoretical value of circulation and angle of attack.

3. Attempt any **FOUR** of the following: [4 × 5 = 20]

(a) What is the irrotational velocity field associated with the potential $\varphi = 3x^2 - 3x + 3y^2 + 16t^2 + 12zt$. Does the flow field satisfy the incompressible continuity equation?

(b) A cylindrical vessel 12 cm in diameter and 30 cm deep is filled with water upto top. Find the quantity of water left when N = 600 rpm.

(c) Find an expression for the drag force on a smooth sphere of diameter D, moving with a uniform velocity V in a fluid of density ρ and dynamic viscosity μ.

(d) Find the distance from the pipe wall at which the local velocity is equal to the average velocity for turbulent flow in pipes.

(e) Define Energy Thickness and derive expression for the same.

4. Attempt any **TWO** of the following: [2× 10 = 20]

(a) What is meant by separation of boundary layer? Explain the effect of pressure gradient on boundary layer separation. Describe the methods to control separation.

(b) Determine the kinetic energy correction factor and momentum correction factor for laminar flow between two fixed parallel plates.

(c) A velocity distribution of a flat plate is prescribed by the relation $\frac{u}{v} = \sin\left(\frac{\pi y}{2\delta}\right)$. Use momentum integral equation to develop an expression for boundary layer thickness, wall shear stress and skin friction coefficient, drag force on one side of plate.

5. Attempt any **TWO** of the following: [2× 10 = 20]

(a) Calculate the time required to empty a cylindrical tank which is half full initially. The inside diameter and length of tank are 2.5 m and 5 m respectively. Orifice at the bottom of tank is 7.5 cm in diameter with C_d = 0.6.

(i) When the tank is vertical.

(ii) When the tank is horizontal.

(b) A siphon pumps water from a large reservoir to a lower tank that is initially empty.The tank also has a rounded orifice 6 m below the reservoir surface, where water leaves the tank, both the siphon and the orifice dia are 5 cm. Ignoring frictionlosses, determine to what height the water will rise in the tank at equilibrium.

(c) Derive Hagen-Poiseuille equation and state the assumptions made.

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