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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Third Semester B.Tech Degree Examination December 2021 (2019 scheme)

Course Code: MET203

Course Name: MECHANICS OF FLUIDS

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all questions. Each question carries 3 marks Marks

1 What is viscosity? What is the cause of it in liquids and in gases? 3

2 Consider a 4 kg copper cube and a 4 kg copper ball submerged in a liquid. Will the buoyant forces acting on these two bodies be the same or different? Explain. 3

3 A stationary probe is placed in a fluid flow and measures pressure and temperature as functions of time at one location in the flow. Is this a Lagrangian or an Eulerian measurement? Explain. 3

4 What is the definition of a streamline? What do streamlines indicate? 3

5 Does the amount of mass entering a control volume have to be equal to the amount of mass leaving during an unsteady-flow process? Explain. 3

6 What are the three major assumptions used in the derivation of the Bernoulli equation? 3

7 Someone claims that the shear stress at the centre of a circular pipe during fully developed laminar flow is zero. Do you agree with this claim? Explain. 3

8 Explain why the friction factor is independent of the Reynolds number at very large Reynolds numbers. 3

9 Define boundary layer thickness, momentum thickness and displacement thickness. 3

10 What is the primary reason for nondimensionalizing an equation? 3

PART B

Answer any one full question from each module. Each question carries 14 marks

Module 1

11 An infinite plate is moved over a second plate on a layer of liquid. For small gap width, d = 0.3 mm, we assume a linear velocity distribution in the liquid. The liquid viscosity is 0.065 Ns/m^2 and its specific gravity is 0.90. Lower 14

plate is fixed and the upper plate is moving with a velocity of 0.3 m/s. Determine :

(a) The kinematic viscosity of the liquid, in m^2/s.

(b) The shear stress on the upper plate, in N/m^2

(c) The shear stress on the lower plate, in Pa.

(d) The direction of each shear stress calculated in parts (b) and (c).

12 (a) What is the difference between gage pressure and absolute pressure? 14

(b) Express Pascal's law and give example of it.

(c) A vacuum gage connected to a tank reads 30 kPa at a location where the barometric reading is 755 mm Hg. Determine the absolute pressure in the tank. Take density of mercury as 13,590 kg/m^3.

Module 2

13 A steady, incompressible, two dimensional velocity field is given by the following components in the xy plane : 14

$u = 1.1 + 2.8x + 0.65y$ and $v = 0.98 - 2.1x - 2.8y$

Calculate the acceleration field (find expressions for acceleration components **a_x and a_y**.), and calculate the acceleration at the point (x, y) = (-2, 3).

14 Consider the flow field given by $\psi = ax^2 - ay^2$ where a = 5 s^{-1}. Show that the flow is irrotational. Determine the velocity potential for this flow. 14

Module 3

15 A pitot tube is inserted in an air flow to measure the flow speed. The tube is inserted so that it points upstream into the flow and the pressure sensed by the tube is the stagnation pressure. The static pressure is measured at the same location in the flow using a wall pressure tap. If the pressure difference is 42 mm of mercury, determine the flow speed. 14

16 Air enters a nozzle steadily at 2.5 kg/m^3 and 28 m/s and leaves at 0.81 kg/m^3 and 178 m/s. If the inlet area of the nozzle is 80 cm^2, determine (a) the mass flow rate through the nozzle and (b) the exit area of the nozzle. 14

Module 4

17 Water at 30°C (**Density = 990 kg/m^3 and dynamic viscosity = 8.9 $x10^{-4}$ Pas**) is flowing through a 6 mm diameter 1 m long horizontal pipe steadily at an average velocity of 1 m/s. Determine (a) the head loss (b) the pressure drop, and (c) the pumping power requirement to overcome this pressure drop. 14

18 (a) Explain why the friction factor is independent of the Reynolds number at very large Reynolds numbers. 14

(b) Consider laminar flow in a circular pipe. Will the wall shear stress be higher near the inlet of the pipe or near the exit? Why?

Module 5

19 Consider two-dimensional laminar boundary-layer flow along a flat plate. Assume the velocity profile in the boundary layer is sinusoidal, 14

$$\frac{u}{U} = sin\left(\frac{\pi}{2}\frac{y}{\delta}\right)$$

Find expressions for : (a) The rate of growth δ, as a function of x. (b) The displacement thickness δ*, as a function of x.

20 The drag force F, on a smooth sphere depends on the relative speed V, the sphere diameter D, the fluid density ρ, and the fluid viscosity μ. Obtain a set of dimensionless groups that can be used to correlate experimental data. 14

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