R09

Code No: C2104

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M.TECH I SEMESTER EXAMINATIONS, APRIL/MAY-2012
ADVANCED FLUID MECHANICS
(THERMAL ENGINEERING)

Time: 3hours **Max. Marks: 60**

Answer any five questions
All questions carry equal marks
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1.a) Define the term circulation and vorticity.
b) A 30 cm diameter pipe carries water under a head of 20 metres with a velocity of 3.5 m/s. If the axis of the pipe turns through 45^0, find the magnitude and direction of the resultant force on the bend.

2.a) Obtain the expression for the boundary shear stress in terms of momentum thickness.
b) Air is flowing over a smooth plate with a velocity of 8m/s. The length of the plate is 1.5m and width 1m. If the laminar boundary exists up to a value of Reynolds number = 5×10^5. Find the maximum distance from the leading edge up to which laminar boundary layer exists. Find the maximum thickness of laminar boundary layer if the velocity profile is given by $\frac{u}{U}=\left(\frac{y}{\delta}\right)-\left(\frac{y}{\delta}\right)^2$. Take ν for air = 0.15 stokes.

3.a) Describe a formula developed by Darcy for loss of head due to friction for the flow through a pipe.
b) A pipe carrying water increased in diameter from 40 cm to 100 cm suddenly. The pressure difference in small and bigger sections is measured by using Hg-U-tube which connected to upstream and downstream of the enlarged section immediately. The difference in pressure is equal to 6 cm of Hg. Find out the discharge through the pipe. Take sp.gr. of Hg = 13.6.

4. a) Set up the Navier-Stoke's equations and make suitable assumptions to prove that: For a hydraulic mass of fluid, the pressure intensity at a depth h below the free surface is equal to the product of specific weight w and the depth h.
b) For a two dimensional steady flow, the pressure gradient in the direction of flow (dp/dx) is equal to shear gradient (dτ/dy) in the direction normal to the direction of fluid motion.

5.a) Obtain an expression for the value of pressure drop in an incompressible, laminar and steady Couette flow such that shear stress at the stationary plate is zero.
b) Two parallel plates are placed 10 mm apart. The bottom plate is fixed and the top plate is moved at a uniform speed of 1 m/s. The fluid in the 10 mm space has a viscosity of 0.08 Ns/m^2. If the pressure drops from 200 kPa to 100 kPa over a distance of 100 m, determine the velocity distribution and rate of flow.

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6.a) Starting with the Navier-Stokes equations of motion for two dimensional incompressible flow, obtain the Prandtl's boundary layer equation.

b) A plate 0.5 m × 0.2 m has been placed longitudinally in a stream of crude oil which flows with undisturbed velocity of 6 m/s. Given that oil has a specific gravity 0.9 and kinematic viscosity 1 stoke, calculate the boundary layer thickness and shear stress at the middle of plate. Also calculate friction drag on one side of the plate.

7.a) What is Mach number? Why is this parameter so important for the study of flow of compressible fluids?

b) An aeroplane is flying at 1000 km/h through still air having a pressure of 78.5 kN/m^2 (abs.) and temperature –8ºC. Calculate on the stagnation point on the nose of the plane: (i) Stagnation pressure,
(ii) Stagnation temperature and
(iii) Stagnation density.

8.a) What are static and stagnation temperatures?

b) A tank fitted with a convergent nozzle contains air at a temperature of 20ºC. The diameter at the outlet of the nozzle is 25 mm. assuming adiabatic flow; find the mass rate of flow of air through the nozzle to the atmosphere when the pressure in the tank is:
i) 140 kN/m^2 (abs.),
ii) 300 kN/m^2. Take for air: R = 287 J/kg K and γ = 1.4. Barometric pressure = 100 kN/m^2.

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