

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° , 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 ($d\tau/dy$) 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 $0.5 \text{ m} \times 0.2 \text{ m}$ 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 -8°C . 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 20°C . 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: $R = 287 \text{ J/kg K}$ and $\gamma = 1.4$. Barometric pressure = 100 kN/m^2 .

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