R09

Code No: C2104

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M.Tech I Semester Examinations, April 2011

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) From the consideration of vorticity and rotation show that in case of ideal fluids the flow is irrotational.
   (b) Water flows through a pipe AB 1.2 m diameter at 3 m/s and then passes through a pipe BC 1.5 m diameter. At C, the pipe branches. Branch CD is 0.8 m in diameter and carries one-third of the flow in AB. The flow velocity in branch CE is 2.5 m/s. Find the volume rate of flow in AB, the velocity in BC, the velocity in CD and the diameter of CE. [12]

2. In the two-dimensional incompressible flow field the velocity components are expressed as

$$U = 2x - x^2y + y^3/3 \quad \text{and} \quad v = -2y + xy^2 - x^3/3$$

   (i) Determine the velocity and acceleration at point P (x=1m, y=3m).
   (ii) Is the flow physically possible? If so obtain an expression for the stream function.
   (iii) What is the discharge between the streamlines passing through (1, 3) and (2, 3)?
   (iv) Is the flow irrotational? If so determine the corresponding velocity potential.
   (v) Show that each of the stream and potential functions satisfy Laplace equation.[12]

3. (a) Derive an expression for the velocity distribution for viscous flow through a circular pipe. Also sketch the distribution of velocity and shear stress across a section of the pipe.
   (b) Two parallel plates are placed horizontally 10 mm apart. The bottom plate is fixed and the top plate is moved at a uniform speed of 0.25 m/s. The fluid between them has a dynamic viscosity μ equal to 1.472 $N.s/m^2$. Determine the pressure gradient which corresponds to the condition of zero discharge between the plates and the shearing stress at each plate.

[12]

4. (a) How are the thickness of boundary layer, shear stress and the drag force along the flat plate determined by Von Karman momentum equation.
   (b) A torpedo which has a surface area of 2.5 m^2 and length 1.5 m is launched in sea water at a speed of 6.5 m/sec. Assuming the boundary layer to be fully turbulent, determine the surface drag and the maximum boundary layer thickness. Assume density and viscosity of sea water 1025 kg/ m^3 and 0.0156 poise. [12]

5. (a) Derive Karman-Prandtl universal velocity distribution law. In what respect is this equation defective?
   (b) For turbulent flow in a pipe of 25 cm diameter, the centre line velocity is 2.25 m/s and the velocity at a point 8 cm from the centre as measured by a pitot tube is 1.95 m/s. Make calculations for (i) friction velocity and wall shearing stress, (ii) average velocity and discharge through the pipe, (iii) friction factor and (iv) pipe roughness. [12]

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6. (a) What do you understand by the hydraulically smooth and rough pipes?
   (b) A pipe line 12 cm in diameter and 100 m long conveys water at the rate of 0.075 m^3/s. The average height of the surface protrusions is 0.012 cm and the coefficient of friction is 0.005. Calculate the loss of head, wall shearing stress, centre line velocity and nominal thickness of laminar sub layer. For water $\rho = 1000$ kg/m^3, $\upsilon = 0.01$ stokes.
   [12]

7. (a) Show by means of diagrams the nature of propagation of disturbance in compressible flow when Mach number is less than one, is equal to one and is more than one.
   (b) A normal shock wave occurs in air flowing at a Mach number of 1.5. The static pressure and temperature of the air upstream of a shock wave are 1 bar and 300 K. Determine the Mach number, pressure and temperature downstream of the wave. Also estimate the shock strength. [12]

8. Explain the following:
   (a) Generalized couettee flow
   (b) Reynolds theory of turbulence
   (c) Variation of velocity with area ratio [12]

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