Code No: R05220302 **Set No. 1**

II B.Tech II Semester Regular Examinations, Apr/May 2007
MECHANICS OF FLUIDS
(Common to Mechanical Engineering, Metallurgy & Material Technology and Automobile Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. The velocity distribution of flow over a plate is parabolic with vertex 30 cm from the plate, where the velocity is 180 cm/s. If the viscosity of the fluid is 0.9 N.s/ m^2 find the velocity gradient and shear stresses at distances of 0, 15 cm and 30 cm from the plate. [16]

2. (a) The velocity potential function for a two-dimensional flow is $\phi = x\,(2y - 1)$ At a point P(4,5) determine:
   i. The velocity and
   ii. The value of stream function.
   (b) Differentiate between the rotational and irrotational flows. [10+6]

3. A 300mm diameter pipe carries water under a head of 20m with a velocity of 3.5m/s. If the a axis of the pipe turn through 45^0, find the magnitude and direction of the resultant force at the bend . [16]

4. (a) Explain working of Hotwire Anemometer.
   (b) An orifice meter is to be fitted into a horizontal pipe 25cm diameter, carrying oil of specific gravity 0.87 for the purpose of flow measurement. The differential head is to be indicated by a U-tube manometer containing mercury (specific gravity=13.6). If the manometer reading is not to exceed 18cm when the flow is 17 kg/sec, what should be the diameter of the orifice? Assume C_d =0.62. [6+10]

5. (a) For a fluid flowing over a flat plate, draw
   i. Velocity distribution in the laminar and turbulent boundary layers
   ii. Shear stress distribution for the boundary layer developing on either side of the plate.
   (b) A plate 4 m x 1.5 m is held in water moving at 1 m/sec parallel to its length. If the flow in the boundary layer is laminar at the leading edge of the plate, find [6+10]
   i. the distance from leading edge where the boundary layer flow changes from laminar to turbulent flow
   ii. the thickness of boundary layer at this section, and
   iii. the frictional drag on both sides of the plate.

6. (a) Derive Darcy-Weisbach equation for loss of head in a pipe.

(b) Two tanks are connected by a 300 mm diameter 1000 m long pipe. Find the rate of flow if the difference of water level in the tank is 10 m. Take 4f = 0.04 and ignore minor losses. [10+6]

7. (a) Show that the momentum correction factor for laminar flow through a circular pipe is equal to 4/3.

   (b) A shaft having a diameter of 50mm rotates centrally in a journal bearing having a diameter of 50.15 mm and length 100mm. The annular space between the shaft and the bearing is filled with oil having viscosity of 0.9 poise. Determine the power absorbed in the bearing when the speed of rotation is 60 rpm [8+8]

8. (a) What is the function of wind tunnel?

   (b) Dry air flows in a duct 30 cm inside diameter .A Pitot tube inserted in the direction of flow measures 15cm water column in a manometer. The static pressure is 5 cm water gauge above atmospheric pressure and the temperature is 17^0C . Determine the velocity of air. Take atmospheric pressure as 10.5 N/ cm^2. [6+10]

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Answer any FIVE Questions
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1. (a) Calculate the specific weight, specific mass, specific volume and specific gravity of a liquid having a volume of 6 m^3 and weight of 44 kN.
   (b) Distinguish between simple manometer and a differential manometer. [8+8]

2. (a) If ϕ=3xy, find x and y components of velocity at (1,3) and (3,3). Determine the discharge passing between streamlines passing through these points.
   (b) Define one-dimensional, two-dimensional and three-dimensional flows? [10+6]

3. (a) What is kinetic energy correction factor?
   (b) The water is flowing through a taper pipe of length 100m having diameters 600mm at the upper end and 300mm at the lower end, at the rate of 50 lit/ s. The pipe has a slope of 1 in 30. Find the pressure at the lower end if the pressure at the upper end is 19.62N/c m^2 [7+9]

4. (a) Define the scale ratio in distorted models and obtain the expression of scale ratio for velocity and scale ratio for area of flow.
   (b) The rate of flow in a 120mm diameter pipe is measured with a venturimeter with a 40mm diameter throat. When a mercury manometer is connected across the converging section reads 7mm, the flow rate is 1.5kg/sec. What is the coefficient of discharge at that flow rate and what is permanent loss of head? (Specific gravity of mercury =13.6). [7+9]

5. (a) Explain with a neat sketch the boundary layer characteristics when a fluid is flowing over a flat plate.
   (b) A thin flat plate 0.3 m wide and 0.6 m long is suspended and exposed parallel to air flowing with a velocity of 3 m/sec. Calculate drag force on both sides of the plate when the 0.3 m edge is oriented parallel to free stream. Consider flow to be laminar and assume for air kinematic viscosity is 0.18 stokes and density is 1.2 kg/m^3. [10+6]

6. A pipeline ABC 180 m long is laid on an upward slope of 1 in 60. The length of portion AB is 90 m and its diameter is 0.15 m. At B the pipe section suddenly enlarges to 0.30 m diameter and remains so for the remainder of its length BC, 90 m. A flow of 50 litres per second is pumped into the pipe at its lower end A and is discharged at the upper end C into a closed tank. The pressure at the supply end A is 137.34 kN/m^2. Sketch [16]

(a) the total energy line

(b) the hydraulic gradient line and also find the pressure at discharge end C. Take f = 0.02 in $h_f = \frac{flV^2}{2gD}$

7. (a) Show that the momentum correction factor for laminar flow through a circular pipe is equal to 4/3.

   (b) A shaft having a diameter of 50mm rotates centrally in a journal bearing having a diameter of 50.15 mm and length 100mm. The annular space between the shaft and the bearing is filled with oil having viscosity of 0.9 poise. Determine the power absorbed in the bearing when the speed of rotation is 60 rpm [8+8]

8. (a) What is meant by co-efficient of compressibility ?

   (b) A diffuser of area 2:1 operates at the inlet conditions P_1 =500KN/m^2, T_1 =500K, Mach number M_1=0.6, K=1.4. Estimate the following at the exit [8+8]

   i. Velocity
   ii. pressure
   iii. Temperature
   iv. Mach number.

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1. Two large fixed parallel planes are 12mm apart. The space between the surfaces is filled with oil of viscosity 0.972Ns/ m^2. A flat thin plate 0.25 m^2 area moves through the oil at a velocity of 0.3m/s. Calculate the drag force:
   (a) When the plate is equidistant from both the planes and
   (b) When the thin plate is at a distance of 4mm from one of the plane surfaces. [16]

2. In a two-dimensional incompressible flow, the fluid velocity components are given by u=x-4y and v=-y-4x . Show that velocity potential exists and determine its form as well as stream function. [16]

3. In a 45^0 bend a rectangular air duct of $1m^2$ cross-sectional area is gradually reduced to $0.5m^2$ area. Find the magnitude and direction of the force required to hold the duct in position .If the velocity of flow at the $1m^2$ section is 10m/s, and pressure is 2.943 N/cm^2.take density of air as 1.16 Kg/m^3 . [16]

4. (a) What is the significance of the following non dimensional numbers in the theory of Similarity?
      i. Reynolds number
      ii. Froude number and
      iii. Mach Number.
   (b) A venturimeter its axis vertical, the inlet and throat diameters being 90 mm and 45 mm respectively. The throat is 150 mm above inlet and Cd =0.96, oil of specific gravity 0.8 flows up through the meter at a rate of 0.01 m^3/s. Find the pressure difference between inlet and throat. [6+10]

5. (a) For a fluid flowing over a flat plate, draw
      i. Velocity distribution in the laminar and turbulent boundary layers
      ii. Shear stress distribution for the boundary layer developing on either side of the plate.
   (b) A plate 4 m x 1.5 m is held in water moving at 1 m/sec parallel to its length. If the flow in the boundary layer is laminar at the leading edge of the plate, find [6+10]
      i. the distance from leading edge where the boundary layer flow changes from laminar to turbulent flow

ii. the thickness of boundary layer at this section, and

iii. the frictional drag on both sides of the plate.

6. (a) Explain Reynolds experiment and the significance of critical velocity.

   (b) A single pipe 400 mm in diameter and 400 m long conveys water at the rate of 0.5 m^3/sec. Find the increase in discharge if another pipe of 200 m log 200 mm diameter is joined parallel with the existing pipe over half of its length. Take friction factor 4f = 0.04. [8+8]

7. (a) What do you meant by viscous flow? Mention various forces to be considered in Navier Stroke's equation.

   (b) Through a horizontal circular pipe of diameter 100 mm and of length 10m, an oil of dynamic 0.097 poise and relative density 0.9 is flowing. Calculate the difference of pressure at the two ends of the pipe, if 100 Kg. of the oil is collected in a tank in 30 seconds. [10+6]

8. (a) Derive Bernoulli's equation for compressible flow undergoing adiabatic process?

   (b) Find the Mach number when an aero plane is flying at 1100Km/hr through still air having a pressure of 7 N/ cm^2 and temperature -5^0C. Wind velocity may be taken as zero. Take R=287.14J/KgK. Calculate the pressure, temp and density of air at stagnation point on the nose of the plane. Take K=1.4. [8+8]

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1. (a) A lubricating oil of viscosity μ undergoes steady shear between a fixed lower plate and an upper plate moving at speed V. The clearance between the plates is t. Show that a linear velocity profile results if the fluid does not slip at either plate.
   (b) Describe with a neat sketch a micro-manometer used for very precise measurement of small pressure difference between two points. [8+8]

2. (a) For a three-dimensional flow the velocity distribution is given by u = -x,v = 3-y and w= 3-z. What is the equation of a streamline passing through (1,2,2)
   (b) A steady flow can be non-uniform. Discuss. [10+6]

3. (a) Write shorts notes on:
      i. Bernoulli's equation
      ii. Euler's equation
      iii. Vertex Flow.
   (b) A closed vertical cylinder 350mm in diameter and height 400mm height is filled with oil of relative density 0.9 to a depth of 280mm, the remaining volume containing air at atmosphere pressure. The cylinder rotates about its vertical axis at such a speed that the oil. Just begins to uncover the base. Calculate the speed of rotation for this condition. [6+10]

4. (a) Explain about horizontal, vertical and Inclined venturimeter by applying Bernoulli's equation at two sections.
   (b) Water flows over a Rectangular sharp- crested weir 1m long, the head over the sill of of the weir being 0.66m. The approach channel is 1.4 m wide and depth of flow in the channel is 1.2m. Starting from the first principle, determine the rate of discharge over the weir. Consider also the velocity of approach and the effect of end contractions. Take Coefficient of discharge for the weir as 0.6. [8+8]

5. (a) Explain with the help of a sketch the variation of drag coefficient for a circular cylinder over wide range of Reynolds number.
   (b) A cylinder of 0.5 m diameter rotates at 540 r.p.m in air stream of velocity 12 m/sec. If it develop a lift of 96 N per unit length of the cylinder, determine the ratio of actual to theoretical lift. Take density of air as 1.236 kg/m^3.[8+8]

6. (a) How the loss of energy at the entrance to the pipe and exit from the pipe is to be determined?

   (b) A horizontal pipeline 50 m long is connected to a water tank at one end and discharges freely into the atmosphere at the other end. For the first 30 m of its length from the tank, the pipe is 100 mm diameter and its diameter suddenly enlarged to 200 mm. The height of the water level in the tank is 10 m above the centre of the pipe. Determine the rate of flow. Take 4f = 0.04 for both sections of the pipe and consider minor losses. [6+10]

7. (a) What do you meant by viscous flow? Mention various forces to be considered in Navier Stroke's equation.

   (b) Through a horizontal circular pipe of diameter 100 mm and of length 10m, an oil of dynamic 0.097 poise and relative density 0.9 is flowing. Calculate the difference of pressure at the two ends of the pipe, if 100 Kg. of the oil is collected in a tank in 30 seconds. [10+6]

8. (a) What do you mean by Sub-sonic, sonic and super sonic flows?

   (b) An Aeroplane is flying at an height of 20km, where the temperature is -40^{0}C .Find the speed of the plane corresponding to Machnumber M=1.8, K=1.4 and R=287J/Kg-K. [8+8]

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